GeoRTD®

User Manual

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GeoRTD® User Manual

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REVISION HISTORY

Rev	Description	Date	Approval
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B	Update UI changes, standardize document layout, Geo-Toolbox and RYO Protocol information moved to their own documents,	4/13/2016	DRAFT

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1.0 Introduction

Welcome to the Geodetics Real-Time Dynamics program: GeoRTD®, hereinafter GeoRTD. The premier software for three-dimensional precise instantaneous GPS ("πGPS") positioning of wide-area networks of static, deforming, and dynamic objects. GeoRTD contains Geodetics' proprietary RNA (Rapid Network Analysis) module with Epoch-by-Epoch™ technology. This innovative technology provides you with an independent estimate of position for each epoch of dual-frequency (L1 and L2) observations to five or more GPS satellites.

GeoRTD also supports geodetic-quality single-frequency (L1) observations for localized networks. The software controls completely the flow of data from a network of GPS receivers to multiple data servers, data archives, and clients (rovers). GeoRTD's server/client functions support precise instantaneous network ("PIN") positioning, while simultaneously monitoring the integrity and possible deformation of the base network, Epoch-by-Epoch™. PIN positioning is a new network-based real-time methodology, not requiring multi-epoch initialization and re-initialization inherent in conventional RTK surveying and network RTK methods.

GeoRTD has been especially designed for real-time, wireless environments, and the software is optimized for extremely fast dissemination and processing of data. You'll find that GeoRTD provides simple and friendly tools to analyze GPS data either in real-time or post-process modes. GeoRTD comes with an extensive online help capability that will assist you in getting familiar quickly with the software. GeoRTD also supports Geodetics' Vector application providing autonomous heading and attitude determination.

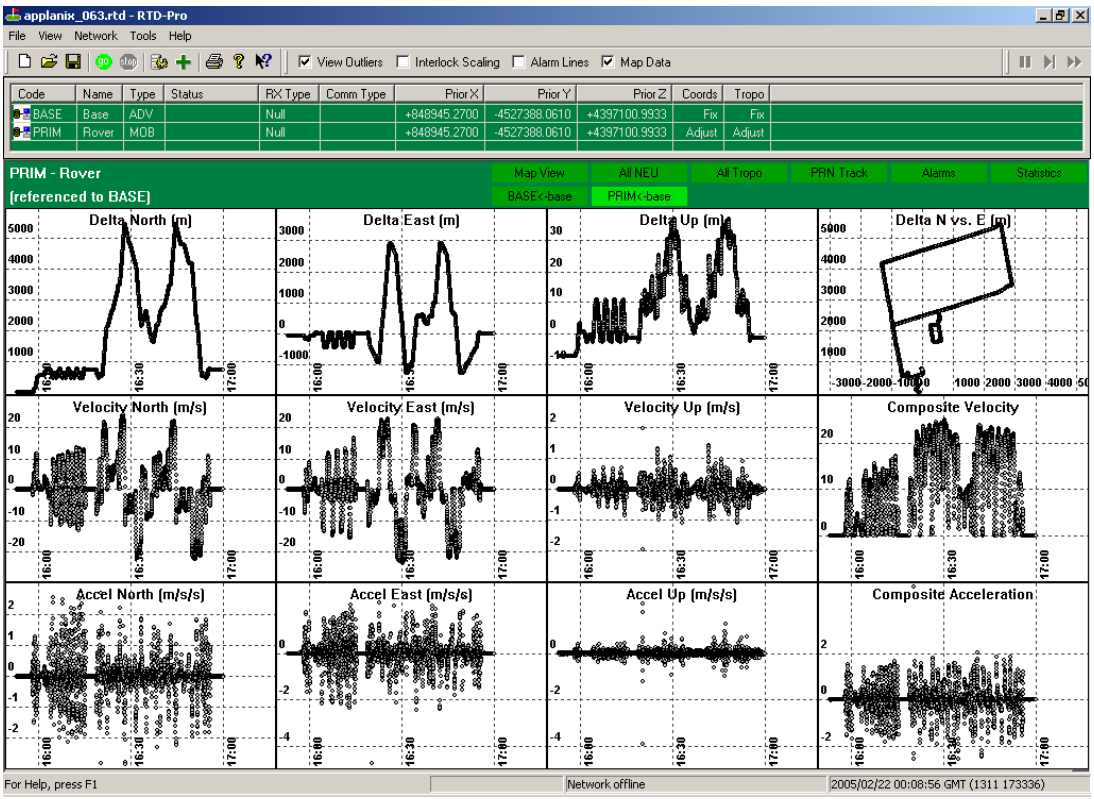

Figure 1 – Screen Shot of GeoRTD Working Environment

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1.1 The GeoRTD package contents

- The GeoRTD CD with soft copy of manual.
- Hard copy of GeoRTD User Manual (optional)

1.2 System requirements

To use GeoRTD, you will need the following hardware and software:

- A PC workstation or laptop.
- Depending on the communication link to the receivers, one or more serial ports and/or network interface cards.
- A hard drive with at least 500 MB of free space.
- At least 128 MB of random-access memory (RAM).
- A CD-ROM drive or access to a portable one for installation.
- A Pentium®, 450 MHz or faster Intel® processor, or equivalent.
- Microsoft Windows® NT, 4.0, 2000, XP, 7, 8.1 or 10
- A video card capable of a minimum screen resolution of 800x600 pixels and 16 bit color.

As with other software packages, GeoRTD performance will improve with faster CPUs, more memory, and faster hard drives. Also, performance may be degraded when run in parallel with other applications.

For real-time applications, the PC workstation must be linked to each of the sites using one or more communication devices such as direct serial connection via an RS-232 cable, a TCP/IP network connection, a dial-up modem, or a spread-spectrum radio modem (not required in post-process mode).

1.3 Supported GPS Hardware, Protocols, and Clients

GeoRTD offers real-time streaming, periodic download, and post-process operational modes, and supports three types of real-time positioning clients (rovers).

Real-time streaming mode currently supports:

- Leica dual-frequency receivers (CRS1000, System500 series, GPS1200 series, GMX902)
- Ashtech dual-frequency receivers (Z series)
- Trimble dual-frequency receivers (4000SSi, 4000 SSE, 4700, 4800, 5700, NetRS, NetR5, R8)
- Topcon dual-frequency receivers
- Novatel & Sokkia OEM4/OEMV dual-frequency receivers
- Navcom dual-frequency receivers

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- RTCM 2.2 (messages 18, 19, 3, 22) and RTCM 2.3 (messages 18, 19, 23, 24) output from any receiver
- Ashtech G12 and AC12 (L1 only)
- Novatel OEMV-1 (L1 only)
- SirF SiRFstarIII (L1 only)

Periodic download currently supports:

- Leica dual-frequency receivers (CRS1000, System500 series)

Post-process mode currently supports:

- RINEX files from any type of single- or dual-frequency geodetic receiver
- Leica data files in LB2 binary or MDB binary format
- Ashtech data files in MBEN/PBEN binary format
- Trimble data files in RT17 format
- Novatel data files in OEM4/OEMV format
- Navcom data files in NCT format
- Topcon data files in GRIL format using the rM message
- SiRF data files following the SiRF binary protocol.

The GeoRTD server supports the following TCP/IP real-time clients (rovers):

- Standard RTK Client – RTCM data from a single base station as specified by user for standard in-receiver RTK
- Enhanced RTK Client – RTCM data from closest base station for in-receiver RTK
- GeoRTD Rover ("Smart Client") – Simultaneous RTCM data from multiple base stations for Epoch-by-Epoch™ PIN (Precise Instantaneous Network) positioning on PDA (for any supported dual-frequency GPS receiver – no in-receiver RTK required)
- RTCM Guest Server – RTCM data from a field receiver to the server, position calculated at the server and returned to the client. (instantaneous inverse RTK)
- Position Server – Epoch-by-Epoch™ positions streamed to external applications in Geodetics RYO format.

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1.4 Limitations

- Minimum number of satellites required for a single-epoch solution: **5** (a solution can be obtained with 4 satellites, but this is not recommended)
- Minimum observable set per satellite: L1 phase, L2 phase, P1 or C/A code pseudorange, P2 pseudorange (optional)[1]
- There is no technical limitation, outside of the processing power of the server upon which GeoRTD is installed, on the number of sites that GeoRTD can manage, however, in the GeoRTD licensing model, a new GeoRTD license is required for each 30 sites.

[1] GeoRTD will perform best using data from dual-frequency GPS receivers. However, for precise positioning at short distances from a base station (<5 km and depending on ionospheric conditions) it is possible to use GeoRTD with single-frequency GPS geodetic receivers.

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1.5 Installation instructions

Run "GeoRTD_Setup" on the GeoRTD installation disk. This program will guide you through the installation process. A third party driver from Safenet (formerly Rainbow Technologies) is also installed automatically. This driver, the Sentinel system driver, is used to access the security key that comes with GeoRTD. The security key, which is provided in the GeoRTD package contents, must be attached to the parallel port or a USB port of the PC on which GeoRTD is to run. GeoRTD will not run without the security key and its driver installed. A parallel port security key is a pass-through device, meaning devices which normally use the parallel port such as printers may still be attached via the security key and still work as they did before. It is sometimes necessary to change the parallel port type to “ECP” in BIOS before the security key will work correctly. Because the security key driver is a system level driver, GeoRTD must be installed on an account with administrator privileges.

GeoRTD uses Microsoft Database Access Components (MDAC) to create and maintain databases for storing long-term statistics. Since MDAC is a part of Windows 98, Windows 2000 and subsequent Microsoft operating systems, no automatic installation of MDAC is performed. However, if you are installing GeoRTD on a NT 4.0 system, you may need to install MDAC. To do this, run “mdac_typ.exe” under the MDAC directory on the GeoRTD installation disk (this can be done after installing GeoRTD).

To completely remove an GeoRTD installation, select the “Add/Remove Programs” icon in the Windows Control Panel, and uninstall “GeoRTD” and “Sentinel System Driver”.

To upgrade to a new version of GeoRTD, you should first uninstall the prior version then install the new version. GeoRTD cannot be running while you do this. The new version of GeoRTD will be compatible with all files from the previous version.

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1.6 LICENSING

Please contact us at licensing@geodetics.com for current pricing. Demo licenses are available on request.

Double-Click the GeoRTD executable to run it.

Unlicensed versions of GeoRTD will come up with an error window that says “Unable to detect the security key…”. It will also create a file named “license_status.txt” in the same folder as the GeoRTD executable.

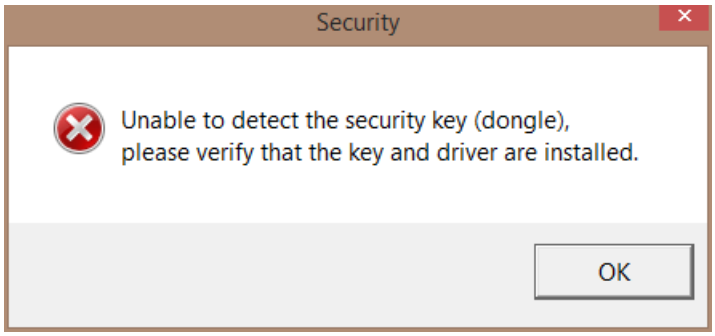

Figure 2 – Missing Security Key

Send a copy of “license_status.txt” to licensing@geodetics.com, it has the information we need to generate a license for you on that machine.

We will generate a “GeodeticsRTD.lic” file and email it to you. You will need to place that file in the same folder as the executable. At that point GeoRTD will function according to your license.

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1.7 GeoRTD with Epoch-by-Epoch™ technology: Summary of Functions

Precise Instantaneous Positioning (GPS) Applications

Static networks, precise instantaneous network (PIN) positioning, deformation (seismic/volcano/landslide) monitoring, structural (bridge/dam/building) monitoring, aircraft approach & landing, precision agriculture, machine control, vehicle tracking, harbor navigation, robotics, GPS/INS integration, intelligent transportation, sports, fleet and product tracking, location based content services.

Operational Modes

Real-time:	Multiple continuous real-time mode connections via serial ports, TCP/IP Sockets (client), or UDP Sockets. Precise (IGS) ultra-rapid orbits obtainable by FTP.
Post-process:	RINEX from single-frequency and dual-frequency geodetic receivers. Various raw data formats. SINEX output. Precise orbits (SP3 format).
RTK:	Standard and Enhanced Clients - Supports conventional in-receiver RTK using RTCM 2.2 and 2.3. Allows for deformation of base network.
GeoRTD Rover:	Initialization-free, wide-area precise instantaneous network ("PIN") positioning from multiple base stations, including ionosphere correction. Troposphere is estimated Epoch-by-Epoch™.
Guest Server:	Instantaneous inverse RTK.
Position Server:	Epoch-by-Epoch™ positions streamed to external applications.
Vector:	Autonomous attitude and heading.

Network Setup

User Interface:	Intuitive, guides the user through the setup process. Includes full on-line help.
Backup:	Multiple network configurations can be defined and saved.
Site Info:	Comprehensive names, coordinates as Cartesian or geodetic, position constraints, GPS receiver and antenna type.
Sensors:	Leica CRS1000, System500, GPS1200, GMX900, Ashtech Z-12, □–Z, z-Extreme, AC-12, G-12, Trimble 4000 SSi, 4700, 4800, 5700, NetRS, NetR5, R8, Navcom receivers, Novatel & Sokkia OEM4, OEMV, OEMV-1. SiRF SiRFstarIII, Topcon receivers. Others on request.

Data

Site Logging:	No PC required at the GPS sensor location.
Archive:	Raw and RINEX data formats. Stored in user-selectable directory structure.
Replication:	Automatic network or FTP transfer of data for archival, and network or Internet FTP and Web access.
Utilities:	RINEX file manipulation; coordinates tool; date/time tool; comm link proxy ("data splitter") for sharing data from a single source among multiple applications.
Database:	Site coordinates database (Microsoft MDB).

Analysis

Algorithm:	Proprietary Rapid Network Analysis (RNA) module with the Epoch-by-Epoch™ positioning algorithms.
Solution:	Independent position computation at each epoch in baseline or network modes.
Precision:	Single-epoch precision*: ± [10-20 mm + 0.2 mm/km)] horizontal 3-5 times less precise in vertical (1 standard deviation). Single-epochs can be averaged for improved static precision.
Range:	Station spacing (nearest neighbor): up to 20-50 km* with dual-frequency receivers unconstrained; up to 250 km with constrained coordinates (only static networks), up to 5 km with L1 receivers.
Rate:	Extremely efficient Epoch-by-Epoch™ algorithms support up to 50 Hz data rates.
Troposphere:	Zenith path delay determined at each site for monitoring atmospheric water vapor content and short-term weather forecasting.

Network Analysis Output

Archive:	GNS solution files for replay including Epoch-by-Epoch™ solutions. SINEX solution files for network adjustment.
Visual Display:	Plots of Epoch-by-Epoch™ solutions for position, velocity and acceleration. Map of site locations.
Logs:	Status and solution statistics.
Alarms:	User-specified alarm tolerances (selective automatic notification of operators).

RTK and DGPS Real-Time Transmission

Formats:	CMR; CMR+, RTCM V2.2, V2.3; NMEA
Local:	Available by connecting a radio and/or cellular phone to each GPS sensor.

*****Accuracy and station spacing are dependent upon GPS satellite system performance, ionospheric conditions, and other factors.

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2.0 GeoRTD Framework – Concepts and Definitions

GeoRTD was designed for real-time positioning of dynamic objects instrumented with GPS systems (receivers/antennas) using Geodetics' proprietary Rapid Network Analysis (RNA) module with Epoch-by-Epoch™ technology. We refer to this capability as precise instantaneous GPS positioning, or pi-GPS positioning, for short. GeoRTD can also be used for static networks, deformation monitoring, navigation (autonomous attitude and heading), and post-processing all of the above. GeoRTD version 2 (and above) supports a TCP/IP-based server/client relationship that allows true real-time, network-based (multiply-determined) instantaneous (Epoch-by-Epoch™) positioning, which we refer to as precise instantaneous network positioning, or PIN-positioning, for short. The GeoRTD client/server relationship eliminates the multiple-epoch initialization and re-initialization of phase ambiguities ("float solutions") required by conventional RTK ("Real-time" Kinematic) surveying, as well as network RTK and VRS methods. The GeoRTD server also provides the unique "GeoRTD Guest" capability, which can be described as instantaneous inverse RTK, and can stream Epoch-by-Epoch™ positions to external applications in several formats.

Epoch-by-Epoch™ positions are instantaneous positions that are fully independent at each epoch of observation. That is, GeoRTD provides an instantaneous snapshot of the receiver geometry at each epoch of observation. At each epoch of observation, GeoRTD performs an independent adjustment of data collected by a group of GPS geodetic systems, which produces a consistent set of positions for each sensor. By GPS geodetic system we mean a sensor that measures both precise code (pseudorange) and phase measurements, either single-frequency (L1) or preferably dual-frequency (L1 and L2). Single-epoch data analysis is a multi-step procedure that requires the resolution of integer-cycle phase ambiguities and the estimation of certain additional parameters such as zenith troposphere delay parameters. It is critical to be able to resolve phase ambiguities to their correct integer values in order to determine position at the centimeter level.

A GPS receiver collects its measurements at regular time intervals - typically the sample interval is set somewhere in the range of 0.1–30 seconds, although modern GPS receivers (and GeoRTD) can operate at very high rates (20–100 Hz). Most GeoRTD applications will require use of the highest sample rate possible with a particular receiver (the exception is static positioning). The precise time at which a given set of simultaneous measurements is made is referred to as the *epoch* of that sample. The signals received by the antenna of a dual-frequency GPS system are processed within the GPS receiver and converted into digital form as time-tagged observations, primarily L1 and L2 carrier phases and L1 and L2 code (pseudorange) measurements from all visible satellites. Single-frequency receivers provide only time-tagged L1 carrier phases and L1 pseudoranges. This numerical time series can be output immediately (in "real-time") via a communication port on the receiver, one epoch at a time, which is known as *streaming* the data.

GeoRTD can provide the absolute positions of one or more moving objects with respect to one or more fixed (static) base stations. In this configuration the coordinates of one base station (called a "Master Site") are required to be known precisely. A special case is "static positioning" where all GPS systems are static and are positioned with respect to the Master Site. GeoRTD can also estimate the relative position between two or more dynamic objects (no static base station needed). In this configuration no object has its absolute position known precisely.

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GeoRTD provides simple and friendly tools to handle GPS data. The online help feature provides all the information required to use the software. This section is meant as a review of some basic geodesy, and to establish a few key concepts and some terminology. The language and ideas developed in this section will be helpful in learning how to setup and run GeoRTD.

2.1 Position Precision

Positioning moving objects

GeoRTD provides the following single-epoch coordinate precision[2] (one-sigma) under normal tracking conditions, using the GPS broadcast ephemeris, and processing with the ionosphere-free phase observable (Note: 1 mm/km = 1 part per million):

Time Period	Horizontal	Vertical
1 epoch	± [10–20 mm + 0.2 mm/km)]	x 3-5

The effective distance for relative positioning is limited by the intensity of ionospheric activity (see *Bock et al*., 2000). In geomagnetic mid-latitude zones, the effective distance is less than 40-50 km; in equatorial and upper-latitude zones, the effective distance may be less than 20 km.

The higher end of horizontal precision is valid for measurements in geomagnetic mid-latitude zones. The lower end is valid for measurements in geomagnetic equatorial and upper latitude zones. The higher end of vertical precision is obtained when tropospheric delay parameters are not estimated (over shorter baselines). The lower end precision is balanced, however, by improved accuracy. If an International GPS Service (IGS) precise ephemeris or equivalent file is available, the proportionality factor will be smaller. For short inter-site spacing (< 5 km), processing with L1 and L2 independent phase observations (not the ionosphere-free observable) will improve coordinate precision by about a factor of three. Also, it is possible to perform relative positioning with geodetic-quality single-frequency (L1-only phase) data over short distances.

[2] These statistics are obtained from examination of multiple 24-hour spans of single-epoch static positions in different geographic regions and geomagnetic zones.

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Positioning Static Platforms

When positioning static platforms, the following precision can be obtained:

Time Period	Horizontal	Vertical
1 epoch	± [10–20 mm + 0.2 mm/km)]	x 3-5
15 minutes	± [8–16 mm + 0.2 mm/km)]	x 3-5
1 hour	± [5–10 mm + 0.2 mm/km)]	x 3-5
6 hours	± [3–6 mm + 0.2 mm/km)]	x 3-5
24 hours	± [2–4 mm + 0.2 mm/km)]	x 3-5

Table 1 – Static Platform Precision

GeoRTD multi-epoch statistics are based on two robust estimators, the median and the interquartile range (IQR), which are less sensitive to data outliers than the traditional mean and standard deviation. The median is used to characterize the central or characteristic value, and the IQR is used to characterize the dispersion of the data about their central value. The IQR is defined as the range of the middle 50% of the data (the difference between the 75th and 25th percentiles). When a data sample is drawn from a normal distribution, its mean very nearly equals its median and its standard deviation equals about three quarters of the IQR.

For intervals longer than a single epoch, the position coordinates for a static platform are determined as the median value of all single-epoch positions within the interval excluding position coordinate outliers. Outliers in GeoRTD for positioning of static platforms are defined by a user-selectable integer multiple of the IQR (the default value of this multiple is 4).

GeoRTD will also output conventional ("Gaussian") statistics (mean, standard deviation). These statistics are stored in binary Geodetics Network Solutions (GNS) files, and can be accessed by using the "Convert GNS to Text" menu option. GeoRTD (version 2 and above) will also output Solution-Independent-Exchange Format (SINEX) files developed by the International GPS Service
http://www.iers.org/IERS/EN/Organization/AnalysisCoordinator/SinexFormat/sinex.html

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2.2 How are site positions expressed?

GeoRTD describes absolute (point) site positions using one of two global coordinate systems: *geocentric* Cartesian coordinates (*i.e.* X, Y, Z), sometimes referred to as ECEF (Earth-Centered Earth-fixed coordinates), or *geodetic* coordinates (ellipsoidal latitude, longitude and height) [e.g. *Teunissen and Kleusberg*, 1998]. When positions are given in geodetic coordinates it is to be understood that the height coordinate refers to height above the ellipsoid (i.e. ellipsoidal height). Orthometric heights (heights above the geoid) are *never* used in GeoRTD.

Relative site positions, *i.e.* inter-site vectors, are described using *topocentric* coordinates (ΔN, ΔE, ΔU), *i.e.* the north, east and up components of the vector running from one site to the other, or using relative Cartesian coordinates (ΔX, ΔY, ΔZ). In the case of topocentric coordinates the up component is in the direction of the local normal to the (WGS84) ellipsoid.

GeoRTD assumes that all coordinate systems are attached to (or refer to) either the WGS84 reference frame (or its ellipsoid), or the International Terrestrial Reference Frame (ITRF – **http://www.iers.org/IERS/EN/DataProducts/ITRF/itrf_cont.html**

At global scales WGS84 and ITRF are nearly equivalent frames of reference. Switching between WGS84 (which is associated with orbital solutions broadcast by GPS satellites) and ITRF (which is associated with precise orbital solutions computed by the IGS) may cause the global coordinates of a site to change by ~ 1 meter. However, for typical GeoRTD applications, the components of the various inter-site (or "baseline") vectors will be effectively unchanged by a switch from one reference frame to the other. For the majority of GeoRTD users, the choice between ITRF and WGS84 is not an important one.

GeoRTD includes an option and a separate utility to transform coordinates to geodetic coordinates with respect to other datums. However, all internal computations are performed in the ITRF/WGS84 reference frame.

2.3 What does site position refer to?

A static GPS site often consists of a *control point* or *marker*, such as a traditional brass survey disk, which is 'occupied' using a GPS antenna. On the other hand, a mobile GPS antenna is attached in some well-defined way to the moving object. GPS analysis actually fixes the spatial coordinates of a reference point on the antenna, known as the Antenna Reference Point (ARP). The *eccentricity* (or *eccentricity vector*) of the antenna is the vector from the marker to the ARP. If the antenna is mounted directly above the marker, the eccentricity is a vertical vector whose length is referred to as the direct antenna height. GeoRTD needs to be told the eccentricity vector associated with each site in order to compute the coordinates of the marker from the coordinates it determines for the ARP. The physical marker is often taken to be that point on the mounting surface of the monument supporting the antenna, which is brought into direct contact with the ARP when the antenna is attached to the monument or moving object. In this case the antenna eccentricity is a vector of zero length. Unless otherwise stated, when we refer to the position of a GPS site we are actually referring to the position of the site marker or control point for a static site or the ARP for an antenna mounted on a moving object.

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It is important to take into account the phase characteristics of the GPS antennas used in the positioning application. The GeoRTD installation disk includes a database for GPS antennas consisting of antenna calibrations by NGS' Geosciences Research Division[3] for a long list of different antennas (using the current "03" format). GeoRTD also supports the older "01" format adopted by the IGS[4]. These antenna calibrations include a measure of the locations of the L1 and L2 phase centers, and variations in phase centers as a function of elevation angle.

These two types of antenna calibration files can be loaded into GeoRTD using the Import Antenna Info command from the Tools menu.

2.4 Absolute versus relative positioning

When we refer to the *absolute position* of a site, we mean the position of that site expressed in global coordinates relative to a specific frame of reference. When we refer to the *relative position* of a site, we mean its position with respect to some other site, which is usually stated by expressing the inter-site vector (or baseline vector) in *topocentric* coordinates or relative Cartesian coordinates, as discussed above. Absolute and relative motions are simply changes in absolute or relative positions, respectively.

GPS geodesy measures relative or *differential* positions more accurately than absolute positions. GeoRTD truly measures only the relative geometry of a group of GPS sensors and it really 'imports' the absolute position of this network by being given in advance (or *a priori*) the absolute position of one (or more) of its sites.

The easiest way and most precise way to describe the trajectory of a moving object is to estimate it with respect to (or relative to) the fixed coordinates of at least one site (the *Master Site)*. GeoRTD provides absolute positions of the moving (or static) objects with respect to the absolute fixed positions of the Master Site. The Master Site, therefore, plays the central role in realizing the reference frame associated with the geodetic analysis. During the geodetic analysis the coordinates of a Master Site are *fixed* to a reference value, and thus do not appear as parameters that are estimated, or *adjusted*, in the geodetic analysis. A formally adopted 'best available' estimate of the absolute position of a site is known as its *reference position*. Site positions that are estimated as part of the geodetic analysis are often said to be *free* or *adjusting*. However, as we shall emphasize below, there can be differing levels of freedom or mobility.

[3] **http://www.ngs.noaa.gov/ANTCAL/Files/ant_info.html (Relative Antenna Calibration File)**
[4] **ftp://igscb.jpl.nasa.gov/igscb/station/general (igs_01.pcv)**

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An *accurate* reference position must be available for any site that will serve as a Master Site. All reference positions used in GeoRTD *must* be stated in ITRF or WGS84 with an absolute accuracy of about 1 meter or less. Since local datums often differ from WGS84 and ITRF by hundreds of meters, great care must be taken to avoid any confusion about the reference frames. For highest accuracies, it is preferable that the Master Site's reference coordinates to be accurate at the centimeter level. There are a variety of ways to determine the precise absolute position of a GPS site in ITRF. A convenient way of doing this is to use one of several Web-based coordinate generators that will determine absolute site coordinates to a precision of about 1 cm from 2-3 days of RINEX data collected at a site (e.g. **http://sopac.ucsd.edu/cgi-bin/SCOUT.cgi** - see also http://igscb.jpl.nasa.gov/overview/links.html#GenLinks for other positioning services). Another option is to determine site coordinates with respect to a local or regional reference network. In this case, it is necessary to know the ITRF coordinates of one of more of the sites in the regional network and it is recommended to use precise orbits from the International GPS Service (http://igscb.jpl.nasa.gov/, **http://www.igs.org/**). We recommend that, if possible, each (fixed) site in your application be positioned with respect to ITRF. Contact Geodetics if you need assistance in determining ITRF site coordinates.

In dynamic applications when all objects are in motion, GeoRTD uses at each epoch the observed L1 and L2 pseudoranges (or L1-only in the case of single-frequency instruments) to estimate their absolute positions and the relative pseudoranges to estimate an initial starting value for their relative positions. The final Epoch-by-Epoch™ relative positions are estimated from L1 (and L2) phase observations whose (doubly-differenced) integer-cycle ambiguities have been resolved. In this configuration, GeoRTD provides only relative positions in the ITRF reference frame.

2.5 Constraining estimated site positions

Sites that are not fixed to their reference values but are estimated (or allowed to 'adjust') during the geodetic analysis are said to be *adjusting*. Adjustable site parameters are never *completely* free in GeoRTD. All estimated parameters are *constrained* to some extent. When positioning a static object, it is straightforward to constrain site positions based on prior information on the coordinates of that site. The GeoRTD default is to fix the Master Site and adjust the others, applying very loose constraints on their *a priori* coordinate values (100 m in each component). But if several of the sites are known to have very accurate reference positions, it is possible to fix them to these sites too, so as to further 'stiffen' the solution for the remaining sites. Site constraints are often said to be tight, moderate or loose. These are relative terms and are not well defined in a numerical sense. Furthermore, this terminology reflects the degree to which a constraint is viewed as reasonable, and not just on its numerical value. A site whose position coordinates are constrained to 0.01 meters is tightly constrained while a site whose position is constrained to 100 meters is loosely constrained. Since the removal of Selective Availability (SA) by the U.S. Department of Defense (the policy of deliberately degrading the performance of GPS accuracy for civilian users) even a constraint of order 10 meters can be characterized as loose. When a constraint is loose then a site's reference positions has little or very little influence on the position that GeoRTD finds for this site. Loosely constrained sites are, for practical purposes, essentially unconstrained. That is loosely constrained sites are *really* free.

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Site constraints are imposed by minimizing a composite or collective measure of the magnitude of the residual vectors for all of the sites being constrained. This composite measure of the disagreement between position solutions and reference positions, sometimes referred to as a penalty function, is formed by summing up the squares of the normalized position residuals for all the sites being constrained. Roughly speaking, this normalization involves dividing the components of the *residual* vector (*i.e.* estimated – reference position) by the standard deviations (or standard errors) assigned *a priori* to a given reference position. Constraining a set of sites in a geodetic analysis involves seeking a solution for the network such that each constrained site is assigned a position that deviates from its reference position only by an amount that is consistent with the formal uncertainty assigned *a priori* to the reference position. For this reason the uncertainties (or standard errors, or standard deviations) that can be assigned to a site (or, properly speaking, to that site's reference position) are often referred to as *site constraints*.

Because GPS measurement errors are greater in the vertical direction than in the horizontal, and because reference positions are almost always determined from previous GPS measurements, it is appropriate to provide differing levels of vertical and horizontal constraint on a site position, reflecting the differing levels of uncertainty associated with the reference position relative to 'truth'. Even in the horizontal plane, it is often apparent that reference positions are better determined in the north direction than in the east direction, or vice-versa. Accordingly, GeoRTD requires the user to provide separate constraints for the three components of uncertainty or constraint. The constraint is easily seen to be a vector quantity when one considers that it actually represents the displacement of the estimated position from the reference position, or the displacement of the reference position from the true position. In principle, site position constraints could be given in geocentric (X,Y,Z) or topocentric (N,E,U) coordinates. Since constraints are really standard deviations, they are always positive quantities. Vertical constraints are typically set looser than horizontal constraints, typically by a factor of 3–5. For this reason it is most reasonable to state site constraints in the (N,E,U) coordinate system.

Obviously when positioning a moving object constraining the positions of this object based on prior information is not possible. However the user can specify that GeoRTD use at each epoch the observed L1 and L2 pseudoranges (or L1-only in the case of single-frequency instruments) to estimate an *a priori* absolute position for each site and that the relative pseudoranges be used to estimate *a priori* starting values for their relative positions. The final Epoch-by-Epoch™ positions (in either kinematic or dynamic configurations) are estimated from L1 (and L2) phase observations whose (doubly-differenced) integer-cycle ambiguities have been resolved.

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2.6 How positions are displayed in GeoRTD

When GeoRTD produces graphical displays of site positions, it plots either (i) *position residuals* – i.e. the deviation of site position estimates from that site's reference position, or (ii) *baseline residuals* – i.e. the deviation of a selected intersite (baseline) vector from the reference baseline vector implied by the reference positions of the associated pair of sites. Both position residuals and baseline residuals are vector quantities expressed in topocentric (N,E,U) coordinates. Either class of residuals can be plotted as (i) a *time series*, *i.e.* N, E or U are plotted against time, (ii) a *horizontal scatter plot*, where N is plotted against E so as to demonstrate horizontal scatter associated with all estimates produced over a period of time, (iii) or a *vertical scatter plot*, where a histogram is used to depict scatter along the U axis.

2.7 Observation file types

For a list of currently supported observation file types, refer to section 1.3, and clients" in the introduction. At any single epoch, GeoRTD requires data from at least five GPS satellites. These data include, for each satellite, L1 phase, L2 phase, and C/A code or P1 pseudorange, and P2 pseudorange, for dual-frequency receivers. For single-frequency receivers, the data include L1 phases and C/A code pseudoranges.

GeoRTD also requires ephemeris information. This information can be obtained

- From the navigation messages collected by the network stations
- A broadcast ephemeris file in RINEX format
- An IGS "auto" file that includes concatenated navigation messages from many global or regional sites in RINEX format
- An IGS file in SP3 format (IGS files can be obtained from **http://igscb.jpl.nasa.gov**, **http://www.igs.org/**)
- GeoRTD version 3.0 (and later) allows for collection of ultra-rapid orbits from IGS analysis centers, suitable for real-time streaming applications if Internet connectivity is available.

When using IGS SP3 files, the tabular elements must exceed the interval of observations by at least 2 hours before the first observation epoch and 2 hours after the last observation epoch.

GeoRTD can also gather and process meteorological files from GPS receivers.

2.8 Types of GPS observables

GeoRTD can produce single-epoch solutions using either independent L1 and L2 phase observations or ionosphere-free linear combinations of phase observations ("LC" or "L3") observations. The LC option should be used when baselines are longer than a few kilometers. For single-frequency receivers the only option, of course, is to use the L1 phase (and code) measurements.

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2.9 Elevation angle cutoff

GPS observations are less precise at low elevation angles, in particular because of the increased effects of tropospheric refraction and the uncertainty in zenith delay mapping functions at low elevations. Setting an elevation angle cutoff and down-weighting observations at low elevation angles are meant to compensate somewhat for the high correlation among zenith delay parameter estimates, vertical coordinate estimates, and antenna multipath.

Most modern receivers can track satellites to low elevation angles. We recommend a 10-degree elevation angle cutoff and the use of GeoRTD's elevation dependent weighting model.

2.10 Estimation of troposphere parameters

Geodetics' unique Epoch-by-Epoch™ technology also permits estimation of a zenith tropospheric path delay ("troposphere delay") parameter simultaneously with site coordinates. This parameter is only a nuisance when the purpose is to monitor site positions and network integrity. However, the zenith path delay is useful if the purpose of the network is to monitor atmospheric water vapor, the most important element in short-term weather forecasting and climate studies (see *Bevis et al*., 1992; *Duan et al*., 1996 for more details).

The user can specify whether or not to invoke troposphere delay estimation. Troposphere delay parameters should be estimated for baselines longer than a few kilometers. GeoRTD starts with a prior model value for the zenith delay at a site. As with site coordinates, troposphere delay parameters have a constraint assigned to them. The default constraint of 0.5 m is a very loose constraint and has little influence on the estimated zenith delay (a typical path delay is about 2.5 meters). A zenith delay can be effectively fixed by applying a very tight constraint (e.g., 0.01 m).

Troposphere delay constraints are applied after ambiguity resolution in the final estimation of parameters. Troposphere delay advanced constraints are used only at the ambiguity resolution stage.

Unlike the coordinates of the Master Site, the troposphere delay parameter can either be fixed or adjusted (with appropriate constraint) at this site. If the parameter is fixed, zenith delay parameters at the other sites are relative to the absolute value assigned to this site by GeoRTD's *a priori* zenith delay model. Alternatively, the zenith delay at the Master Site can be allowed to adjust. In GeoRTD's dynamic configuration, the zenith delay at all sites should be allowed to adjust, in the event that troposphere delay parameters are estimated.

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2.11 The meaning of outliers in GeoRTD (Static Mode Only)

GeoRTD statistics are based on two robust estimators, the median and the interquartile range (IQR), which are less sensitive to data outliers than the traditional ("Gaussian") mean and standard deviation. The median is used to characterize the central or characteristic value, and the IQR is used to characterize the dispersion of the data about their central value. The IQR is defined as the range of the middle 50% of the data (the difference between the 75th and 25th percentiles). When a data sample is drawn from a normal distribution, its mean very nearly equals its median and its standard deviation equals about three quarters of the IQR. Outliers are defined in GeoRTD as points that exceed a user-specified integer multiple of the IQR of a coordinate time series. The default multiple is four times the IQR (about 3-sigma for a normal distribution) and can be changed on the Network Configuration: Statistics Property Page.

Outliers may result from data quality problems, multipath and other site-specific errors (e.g., signal attenuation, signal diffraction, apparent variations in antenna phase centers), atmospheric refraction, orbital errors, and incorrect choice of integer-cycle phase ambiguities.

2.12 The meaning of iteration in GeoRTD

GeoRTD starts with user-specified *a priori* values (reference positions) for site coordinates. Adjustments are estimated for these parameters independently at each epoch by means of a linearized least-squares algorithm. The user can specify that the adjustment be repeated (iterated), either a certain number of times or until the adjusted values are within a certain threshold. On the other hand if the adjustments are expected to differ only slightly from the *a priori* values (e.g., with a multi-site base network) it is more efficient not to iterate on the adjustment parameters.

The user can choose to update the reference positions based on an absolute pseudorange solution, or based on a relative pseudorange solution for a site with respect to the Master Site.

2.13 Statistical output (Static Mode Only)

GeoRTD outputs parameter estimates and statistical data every time a median value is computed for a span of single-epoch solutions. The last median solution is kept in memory and can be accessed through the user interface. The complete history of a project is stored in a disk file named "…_stats.txt".

The statistics file contains the time span of the median solution and the following information for each site:

- Adjusted ITRF X,Y,Z values (meters). The Master Site will display its *a priori* values.
- Adjusted WGS84 Geodetic latitude, longitude, and height (decimal degrees, meters). The Master Site will display its *a priori* values.

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- Topocentric N,E,U values relative to Master or Reference site (meters). Zero values will appear for Master Site.
- Topocentric N,E,U, values relative to *a priori* values, i.e. the adjusted values (meters). Zero values will appear for Master Site.
- Total number of single-epoch solutions within the time interval.
- Number and percentage of single-epoch outliers within the time interval.
- Number of non-solutions. These are single-epoch solutions rejected by GeoRTD.
- IQR statistics in delta North, East, and Up (topocentric) coordinates.
- Table of PRN use statistics.
- Optionally, baseline information between each site and every other site in the network.

2.14 Network output file

GeoRTD has the option to create and store a binary output file. The Geodetics Network Solution (GNS) file (.gns extension) stores at each epoch a record of all necessary solution data for the network. GeoRTD also allows the user to graphically view these types of files as well as convert the contents or a subset of the contents of a GNS file into an ASCII file for easy viewing.

GeoRTD (version 2 and above) will also output Solution-Independent-Exchange Format (SINEX) files (see **ftp://igscb.jpl.nasa.gov/pub/data/format/sinex.txt**). GeoRTD is currently compliant with SINEX version 1.0.

2.15 GeoRTD servers

GeoRTD version 2 (and above) supports a TCP/IP-based server/client relationship that allows true real-time, network-based (multiply-determined) instantaneous (Epoch-by-Epoch™) positioning, which we refer to as precise instantaneous network positioning, or PIN-positioning, for short. The GeoRTD client/server relationship eliminates the multiple-epoch initialization and re-initialization of phase ambiguities ("float solutions") required by conventional RTK ("Real-time" Kinematic) surveying, as well as network RTK and VRS methods. The GeoRTD server also provides the unique "GeoRTD Guest" capability, which can be described as instantaneous inverse RTK, and can stream Epoch-by-Epoch™ positions to external applications. GeoRTD supports standard RTK base station functionality with the "Standard" and "Enhanced" RTK servers. Using these servers, RTK rovers can receive RTCM from GeoRTD from any of GeoRTD's network sites in the case of the "Standard" RTK server and from the closest GeoRTD network site in the case of the "Enhanced" RTK server.

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[5] GeoRTD makes use of the LAMBDA software developed at Delft University of Technology by the group of Professor Teunissen. We hereby acknowledge the authors of the software for making it available to us.

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3.0 Quick Start with GeoRTD

3.1 Before You Begin

For real-time networks, it is important that the PC clock be set fairly accurately (within 10 minutes) before the network is started. GeoRTD uses the PC time to schedule various tasks and interpret protocol timestamps that sometimes only contain offset into the GPS week or in the case of RTCM offset into the current hour. There is an option on the network configuration processing options page to keep the PC time up to date from receiver time once the network is started.

For antenna model information to be available in properties for sites, and antenna model file needs to be imported. Antenna model files are included on the installation CD, and are imported with the main menu command “Tools/Import Antenna Info”. This is described in detail further in the manual.

GeoRTD maintains two types of databases. One is a single database named “GeodeticsGeoRTD.mdb” and contains global settings for GeoRTD. This database is kept in the same directory as the GeoRTD application. The other type of database is a long-term statistics database. One of these is created for each GeoRTD configuration file and is kept in the same directory as the configuration file. Do not delete these files.

3.2 GeoRTD Operational Overview

The data collected by GeoRTD consist of raw GPS observables (phase and pseudorange), GPS satellite orbital information (“orbits”, “ephemeris”), and (optionally) meteorological and auxiliary data. GeoRTD uses this information to determine the positions of the data sources (πGPS), present the positions graphically, and to distribute data to network users (PIN positioning). The collective group of data sources from which GeoRTD collects data is referred to hereafter as a *network*, each data source is referred to as a *site or station (“site” and “station” are used interchangeably)*. Sites are either actual GPS receivers, or data files previously recorded from a GPS receiver. GeoRTD can also obtain precise ephemeris data from the Internet.

When using GeoRTD, you first define networks of GPS receivers (or files) and their communication link to your PC, properties associated with specific sites and communication links, and properties of the network in general. You then run the network to collect data and view the results. This is all done through the GeoRTD graphical user interface. Your definition for a GeoRTD network is saved in a network *configuration file*, a file on your PC where GeoRTD saves all the information you entered about your network. These files have an “.GeoRTD” file extension. You may have several different GeoRTD configuration files if you want to work with more than one network. You may close your GeoRTD configuration, then come back later and open your configuration files to resume work on them.

There are three distinct GeoRTD network configuration modes:

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1) **Real-time** (streaming) – This type of network contains GPS receivers that are tracking the satellites continuously and are accessible through a dedicated communications link. The communications link may be through a combination of radio modems, dial-up modems, satellite modems, direct serial port connections, or the Internet (TCP/IP protocol). GeoRTD sends commands to each receiver to initiate and/or modify the continuous flow ("streaming") of GPS and auxiliary data to the computer workstation. GeoRTD receives the data in "real-time," with the latency determined by the communications link (a fraction of a second, for radio modems, for example). The received data are manipulated according to user settings in the GeoRTD configuration. Nearly all configuration settings can be entered or modified by the user dynamically, that is while GeoRTD is streaming data. For example, the user can modify the sampling rate of a receiver, enter a new site, or decommission a site, without disturbing all other operations. (Note: this mode supports most geodetic-quality GPS receiver models. For a list of currently supported receiver models, refer to section 1.3 Supported GPS Hardware, Protocols, and Clients in the Introduction. Geodetics will entertain customer requests for implementing other receiver models).

2) **Post-processing** – This type of network contains references to files previously recorded from GPS receivers, there is no communication with a "live" operating network. This mode can also be used to replay and process a real-time configuration (see mode 1), or post-process previously recorded data with a modified configuration (for example, using precise IGS orbits or a different satellite elevation angle. The GPS data could come from anywhere in a variety of formats (e.g., RINEX). For a list of currently supported input formats, refer to section 1.3 in the Introduction.

3) **GNS Playback** – This type of network allows the user to replay, view, and manipulate previously recorded GeoRTD network solutions. The input is a Geodetics Network Solution (GNS) file.

3.3 Quick Start: Real-Time Mode

After the receiver network is installed and the receivers configured for use with GeoRTD, the GeoRTD network configuration must be defined. To execute GeoRTD double-click its icon and the GeoRTD working environment (user interface) will appear on the screen. Sites are added to the network via the menu item "Network/Add Site" or the green plus sign icon on the toolbar. Click on the green plus sign icon or pull down the menu "Network/Add Site". Choose "Real-time sites broadcasting data" and then proceed to respond to the sequence of menus that will appear as dialogs on the screen.

When adding a site to a network, you will be prompted to supply the following information:

- For the first site in a network, the type of network you are defining. For a network streaming live data, specify that the network will contain "Real-time sites broadcasting data ".

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- The receiver type. Choose the receiver type from the available list. Real-time mode supports most geodetic-quality GPS receiver models. For a list of currently supported receiver models, refer to section 1.3 in the Introduction. Geodetics will entertain customer requests for implementing other receiver models.
- The type of communication link to the receiver. Select "Direct Serial Connection", "Generic Modem", or “TCP/IP Socket” depending on your physical configuration.
- The site information:
  - Site ID. Specify a four-character site code, a site name of your choosing, the receiver serial number, the reference site, and whether or not data will be retrieved and processed from the site.
  - Antenna. Specify the antenna type, antenna serial number, and the offsets of the antenna from the entered site location. As mentioned earlier, GeoRTD maintains a database of calibrated GPS antennas imported from IGS or NGS antenna files. The calibration includes a measure of the locations of the L1 and L2 phase centers, and variations in phase centers as a function of elevation angle.
  - Site Location. Specify the location of the site. It is especially important for the Master Site that the location be accurate to less than one meter in the ITRF or WGS84 reference frame, and preferably accurate to the centimeter-level. For non-Master Sites, the location should be accurate to within several hundred meters. For deformation monitoring networks, it is useful for all ITRF coordinates to be entered as accurately as possible at a reference epoch (e.g., 2004.0).
  - Site Location Constraints. The Master Site should be added to the network first (although it can be modified at any time). Set the coordinate constraint type of the Master site to “Reference” with “Fixed” checked. For all other sites, set the coordinate constraint type to stationary, or use the “Advanced Settings.” Set the “Tropospheric Delay Constraint” to “Adjust” for all stations.
  - Receiver type specific settings. The main setting available for most receiver types is the sample rate, the rate at which measurements are to be taken and sent back to GeoRTD. Depending on the receiver, there may also be options to specify settings for elevation mask and presence of a met sensor.
- The communication device settings.
  - When selecting a direct serial connection you will need to select a port and baud rate.
  - When selecting a TCP/IP socket you will need to provide an IP address and port number.

When this information is entered for a site, the site will appear in the site list, the sizable window at the top portion of the GeoRTD user interface. Right-click or double-click a site in the site list to modify the information for that site. Once all sites for the network have been added and configured, save the network configuration via the menu item "File/Save Project". This will save the entire network configuration to a disk file for use in subsequent sessions of GeoRTD.

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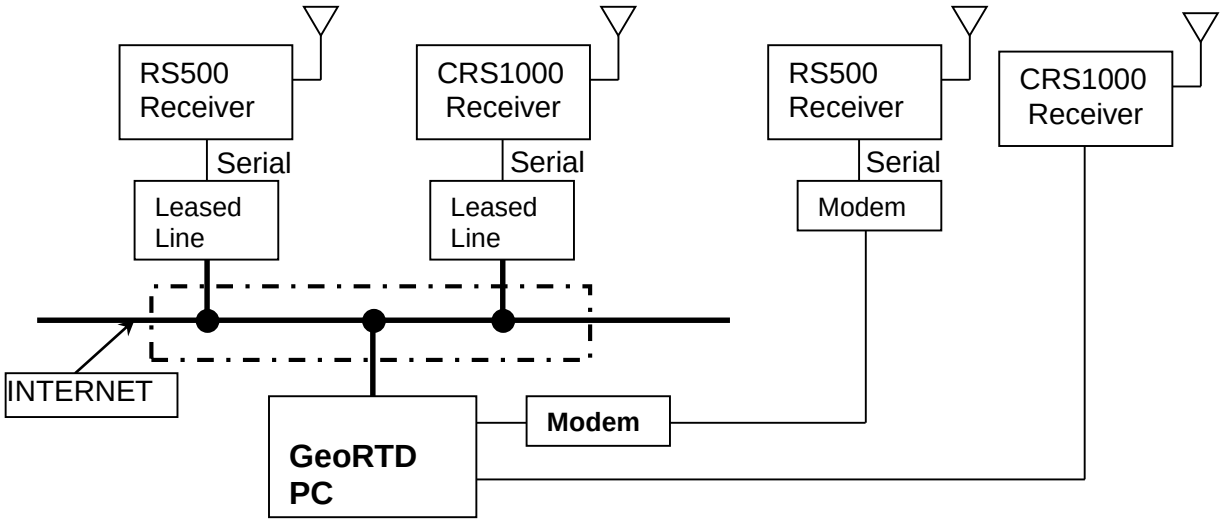

Figure 3 – Diagram of a GeoRTD Control Network.

Next, you may specify GeoRTD settings that affect the entire GeoRTD network. These settings are reached via the menu item "Network/Configuration". For example, under the "Processing" tab of the network configuration window, the elevation cutoff can be set to 10 degrees. And if it is desired to save the information being processed to disk files for later post-processing, specify location files and directories under the "Store" tab. Settings for other options should be left at the defaults.

Finally, the network is ready to run. Put the network online to begin collecting and processing data via the menu item "Network/Go Online" (or clicking the green “GO” button on the toolbar). When you put the GeoRTD network online all receivers are connected to immediately and GeoRTD begins collecting and processing data from the receivers in real-time. The connections to the receivers are maintained the entire time the network is online.

3.4 Quick-Start: Post-Process Mode

First the GeoRTD network must be defined. To execute GeoRTD double-click its icon and the GeoRTD interface will appear on the screen. Sites are added to the network via the menu item "Network/Add Site" or the green plus sign icon on the toolbar. Click on the green plus sign icon or pull down the menu Network/Add Site. Choose “Post-processed sites read from disk” and then proceed to respond to the sequence of menus that will appear as dialogs on the screen.

When you add a site to a post-processing GeoRTD network, a file browsing window titled “Select sample file” will appear. The sample file can be any RINEX or raw receiver data file from the site being added. It is not necessary to specify a sample file, however if one is chosen much information about the site can be extracted and used to automatically fill in some site properties. If no sample file is chosen, all properties for the site will need to be manually entered.

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When adding a site to a network, you will be prompted to supply the following information:

- Site ID. Specify a four-character site code, a site name of your choosing, the receiver serial number, the reference site, and whether or not data will be retrieved and processed from the site.
- Antenna. Specify the antenna type, the antenna serial number, and the offsets of the antenna from the entered site location. As mentioned earlier, GeoRTD maintains a database of calibrated GPS antennas imported from IGS or NGS antenna files. The calibration includes a measure of the locations of the L1 and L2 phase centers, and variations in phase centers as a function of elevation angle. Note: Specifying the correct antenna model and offsets is important for optimal precision and reliability.
- Site Location. Specify the location of the site. It is especially important for the Master Site that the location be accurate to less than one meter in the ITRF or WGS84 reference frame, and preferably accurate to the centimeter-level. For non-Master Sites, the location should be accurate to within several hundred meters. For deformation monitoring networks, it is useful for all ITRF coordinates to be entered as accurately as possible at a reference epoch (e.g., 2004.0).
- Site Location Constraints. The Master Site should be added to the network first (although it can be modified at any time). Set the coordinate constraint type of the Master site to “Reference” with “Fixed” checked. For all other sites, set the coordinate constraint type to stationary, or use the “Advanced Settings.” Set the “Tropospheric Delay Constraint” to “Adjust” for all stations.

When this information is entered for a site, the site will appear in the site list, the sizable window at the top portion of the GeoRTD user interface. The information for a site may be modified at any time by right-clicking on it in the site list. Once all sites for the network have been added and configured, save the network configuration via the menu item "File/Save Project". This will save the entire network configuration to a disk file for use in subsequent sessions of GeoRTD.

Next, you may specify GeoRTD settings that affect the entire GeoRTD network. These settings are reached via the menu item "Network/Configuration". For example, under the "Processing" tab of the network configuration window, the elevation cutoff can be set to 10 degrees. Settings for other options should be left at the defaults.

Recorded data from a site will come in discrete time segments, usually daily files or smaller, and can be RINEX or receiver specific protocols. Sites in GeoRTD post-processing are intended to be reusable on different subsets of data. To that end, sites in an GeoRTD post-processing network are not associated with any specific file or protocol. GeoRTD will automatically determine the protocol of files to be processed, and which site a file is associated with, if any.

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The “Path/Time” tab of network configuration determines which are post-processed. A path to the files to be processed is set on this tab, and it may be a single directory or a directory subtree. The time span to be processed must also be specified, and a file to site association rule. GeoRTD associates files to sites by matching the site code of a site to a subset of the file name, the site code must appear somewhere in the file name. Site codes must be four characters in length. The location of the site code may be anywhere in the file names, and the position in the file name is specifiable on this window. The position of the site code in the file name must be consistent for all files to be processed.

When starting post-processing, GeoRTD examines all files in the selected data path. It determines the type of file, which may be, for example, RINEX observables, Leica LB2, Leica MDB, Ashtech binary MBEN, Topcon GRIL, or Trimble RT17. RINEX ephemeris and SP3 precise ephemeris files are also recognized. For a list of currently supported input formats, refer to section 1.3 in the Introduction. After determining the file types of all files in the data path, GeoRTD determines the time span covered, and matches files to site using the association described in the last paragraph. All files of a recognized protocol associated with a site in the network within the specified time are processed.

Two processing modes are provided, multiple session and single session. For multiple session mode a separate processing session is performed for each date between and including the specified start and end date, and for each date/session only data between the specified start and end times is processed. So in multiple session mode the start/end dates and start/end times are not associated. In single session mode, all data between the starting date and time and the ending date and time are processed in a single session. All data for a session is loaded to memory before processing, so multiple session mode is useful for processing large amounts (days or weeks) of data in segments, single session mode provides for processing an experiment or day or less of data interactively.

The source of ephemeris is specified on the “Ephemeris” tab of network configuration. If “Use ephemeris from raw site data” is selected, ephemeris messages from raw receiver protocol files are used. If RINEX or SP3 ephemeris files are used, then any files of the specified type in the data path are used as a source of ephemeris. GeoRTD version 3.x allows for collection of ultra-rapid orbits from IGS analysis centers, suitable for real-time streaming applications if Internet connectivity is available.

Finally, the network is ready to run. Select the time span to process under “Network Configuration/Path/Time.” Then put the network online to begin collecting and processing data via the menu item "Network/Go Online" or the green “**Go**” button on the toolbar. GeoRTD should then:

- Go online. The contents of the second to right box in the status bar (in the lower right corner of GeoRTD) should change from "Network Offline" to "Processed Year/MM/DD Time" with Time quickly incrementing through the range of data being processed.
- Download data for all sites in the network. The status column in the site list for all sites should go to “downloading”, then displays the observable message time currently being accessed until the download is finished.

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- Calculate the epoch solutions for the data. Data points should begin to appear on the graphs in the main GeoRTD window. If "All sites" view is selected, solution points will begin to appear in each graph for each site. If view of an individual site is selected, solution points will begin to appear in the upper 4 graphs for the site.
- Calculate statistics for the solutions over the interval.

Once GeoRTD starts calculating the epoch solutions for the data, you can pause the playback and step through the data one epoch at a time using the post process playback control, which appears on the GeoRTD user interface for post processing networks.

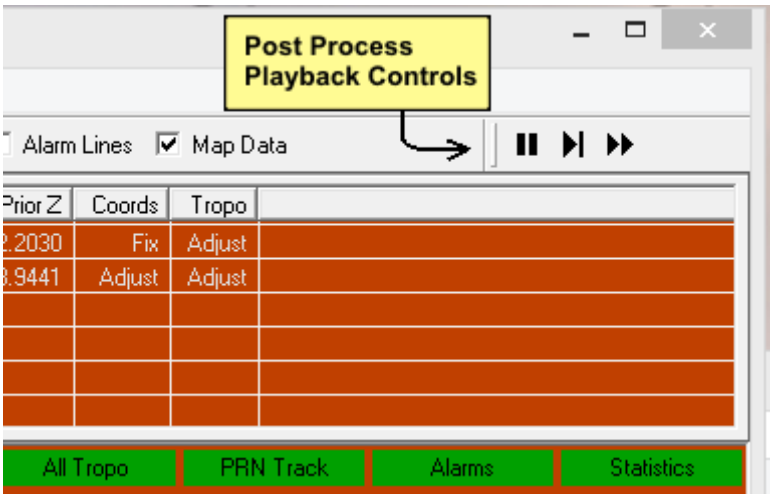

Figure 4 – Playback Controls

Important: By default, data files created by post-processing (RINEX files and GNS files) are deleted and regenerated on each post-processing run. Do not place other files in the RINEX and Network Solutions directories that GeoRTD creates. You can choose not to delete the files through the “Tools/Global Options” menu by disabling “When starting post-processing, remove files/statistics from prior sessions” On the Global Settings tab. This option is useful when appending new post-processed solutions to a previous post-processing session.

3.5 Quick-Start: Viewing GNS Files

When running with live receivers or post-processing data, GeoRTD can optionally record position solutions to a binary file, referred to as a GNS (Geodetic Network Solution) file. GeoRTD also has a mode where GNS files may later be played back to be viewed. To do this, create a new GeoRTD configuration, and when asked for the mode of operation, select “Viewing network solutions (GNS file)”. You will then be prompted to select a GNS file for playback. After this, save the new configuration and it’s ready to run. Simply hit the “go” button on the tool bar and the sites will automatically be inserted and solutions plotted as recorded by the GeoRTD session from which the GNS file originated. You can vary the statistical settings under the “Stats” menu.

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3.6 Description of GeoRTD's Graphical User Interface

The GeoRTD GUI (Graphical User Interface) includes the following sections from top to bottom of the screen:

(1) ***Drop-down Windows Menus*** **–** File, View, Network, Tools, Help (all menu commands are defined in detail in a following section).

(2) ***Toolbar*** **–** Intuitive icons that give you quick access to the most commonly used features (all toolbar buttons are defined in detail in a following section).

(3) ***Special Graphics Functions*** **–** View Outliers, Interlocked Scaling, Alarm Lines, Map Data, Velocity (all special graphics functions are defined in detail in a following section)

(4) ***Site Window*** **–** A list of all sites/receivers in your GeoRTD configuration listing Code, Name, Type ("M" for Master or " " for Free), Download/Processing Status, Receiver/File Type, Prior Cartesian Coordinates (X,Y,Z) or Geodetic Coordinates, Coordinates and Troposphere Parameterization (fixed or adjusted) (see section on following pages for more information).

(5) ***Screen Graphics*** **–** Different graphical displays of the data in the network including Map View, All NEU, All Tropo, Alarms, Statistics, Baseline Pairs (see the "GeoRTD Screen Graphics Window" section for more information)

(6) ***Status Bar*** **–** Date, Time, GPS Week, GPS Seconds of Week, GeoRTD Status (see "Status Bar" section for more information).

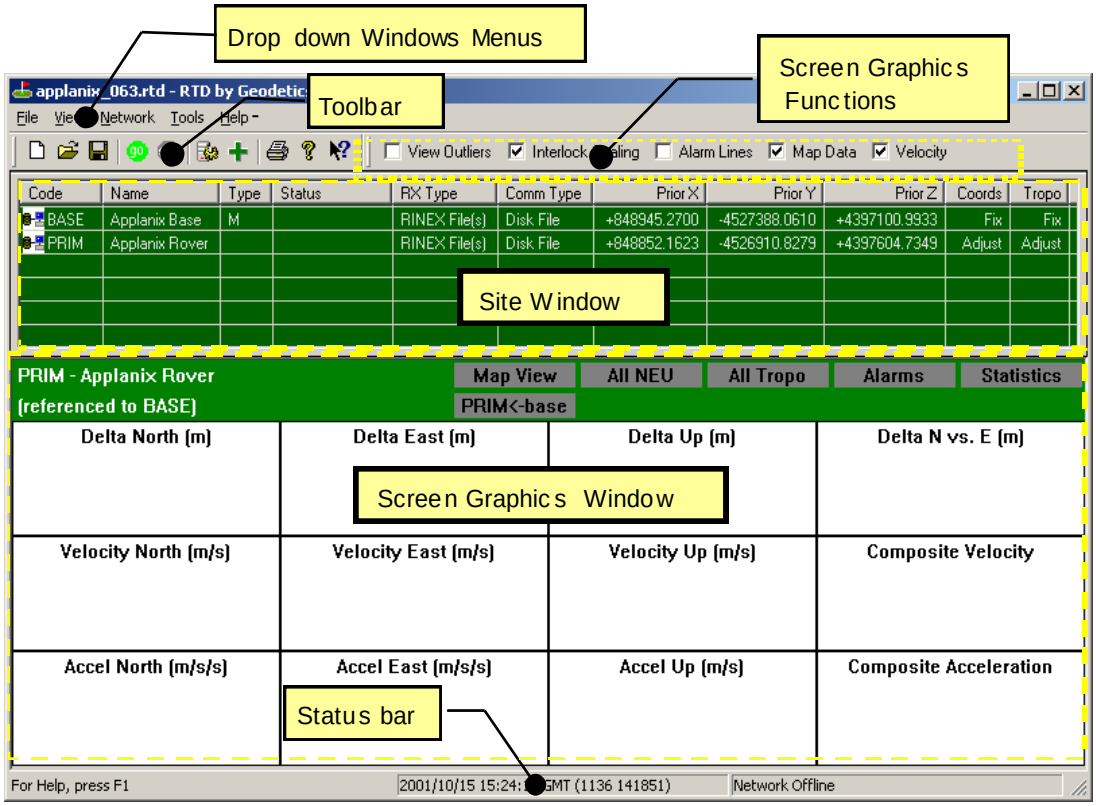

Figure 5 – GeoRTD Graphical User Interface Sections

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The background of the Site Window is color-coded to provide a convenient visual cue depending on the network type selected. The following default color codes are relevant:

- Real-time Network **Green**
- Post-process **Orange**
- GNS Playback **Turquoise**

These color codes may be changed via the menu item “Tools/Global Options”.

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3.7 Toolbar

The toolbar is displayed across the top of the application window, below the menu bar. The toolbar provides quick access to commonly used GeoRTD commands. To hide or display the Toolbar, choose Toolbar from the View menu (ALT+V).

Figure 6 – GeoRTD Toolbar

Icon:	Function:
	Create a new project/configuration file. The same function is also accessible from the File menu.
	Open an existing project. GeoRTD displays the Open dialog box, in which you can locate and open the desired project file. The same function is also accessible from the File menu.
	Save the active project or template with its current name. If you have not named the project, GeoRTD displays the Save As dialog box. The same function is also accessible from the File menu.
	Start network data collection, processing, and storage. In post-processing mode, you can read in an existing project file and start processing by simply clicking this button. The same function is also accessible from the Network menu.
	Stop processing. Clicking this button will reset the project to its initial state (not the state when the button was clicked). The same function is also accessible from the Network menu during processing.
	Configure network. Clicking this button will bring up the Network Configuration menu consisting of several sub-menus. The same function is also accessible from the Network menu.
	Add site to the network. When opening a new project, click this button first to define the mode of operations and then the network, site by site. When working on an existing network configuration, click this button to add a new site. The same function is also accessible from the Network menu.
	Print a document. The same function is also accessible from the File menu.
	About GeoRTD. This window provides GeoRTD's version number, the version of Geodetics' proprietary RNA library, whether or not TCP/IP is enabled, the maximum network size (number of sites) that your installation of GeoRTD is authorized to process, the number of simultaneous instances, the serial number, security key code and expiration date for your installation of GeoRTD. The same function is also accessible from the Help menu.
	Context-sensitive help. Click this button and then click a menu item, toolbar icon, or screen graphics button to access help information on that item.

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3.8 GeoRTD's Site Window

The Site Window resides directly below the Toolbar and displays a summary of relevant information for each site in the network.

Code	Name	Type	Status	RX Type	Comm Type	Prior X	Prior Y	Prior Z	Coords	Tropo
WDR_	West Dam Reference	M		RINEX File(s)	Disk File	-2418456.5801	-4732710.0903	+3515198.8517	Fix	Fix
WDNE	West Dam North Eccentric			RINEX File(s)	Disk File	-2417905.8493	-4731902.0847	+3516620.7396	Adjust	Adjust
WDSE	West Dam South Eccentric			RINEX File(s)	Disk File	-2418054.3397	-4732205.8005	+3516113.3730	Adjust	Adjust
SADD	Saddle Dam			RINEX File(s)	Disk File	-2416372.7996	-4731446.7750	+3518275.0997	Adjust	Adjust
EDS_	East Dam South			RINEX File(s)	Disk File	-2411438.0684	-4734677.3943	+3517321.2884	Adjust	Adjust

Figure 7 – Site Window

The columns contain the following information:

Name	Description
Code	The site code. This must be a 4-character (or less) site id.
Name	The site name.
Type	Whether a site is a Reference (Ref), Mobile (MOB), Stationary (STA) or Advanced (ADV)
Status	Denotes whether site data is being downloaded or read in for post-processing and shows the progress being made.
RX Type	The type of receiver (e.g., Leica RS500) or file type in post-process mode.
Comm Type	The method of communication with the site (e.g., modem or direct serial connection) or type of source file for post-processing (e.g., Disk File).
PRIOR X, PRIOR Y, PRIOR Z	The prior Cartesian coordinates for a site (in ITRF/WGS84). These values are considered 'truth'.
Coords	Whether the site coordinates are fixed or adjusted.
Tropo	Whether the troposphere delay parameter is fixed or adjusted.

Table 2 – Site Window Columns

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3.9 Status Bar

The status bar is displayed at the bottom of the GeoRTD window. To display or hide the status bar, use the Status Bar command in the View menu.

The left area of the status bar describes actions of menu items as you use the arrow keys to navigate through menus. This area similarly shows messages that describe the actions of toolbar buttons as you depress them, before releasing them. If after viewing the description of the toolbar button command you do not wish to execute the command, then release the mouse button while the pointer is off the toolbar button.

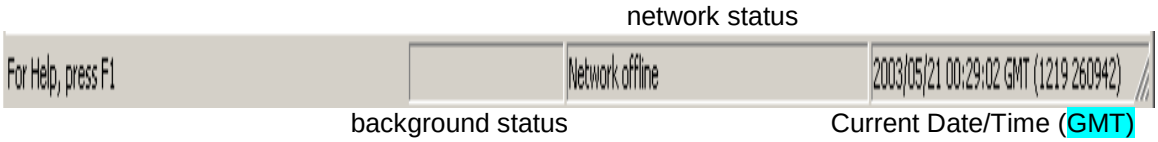

Figure 8 – Status Bar

The right three boxes or panes of the status bar (shown above) indicate the following:

- Status of any background tasks (such as file transfers).
- Current network status.
- Current Date (year/month/day) and Greenwich Mean Time (GMT) in hour:min:sec and GPS week/second formats. These dates and times are from the PC clock.

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4.0 GeoRTD's Screen Graphics Window

The main portion of the GeoRTD display is the Screen Graphics Window. This area displays data from the GPS network in different formats and levels of detail. Each of these different formats is referred to as *views*. The upper part of this window contains the title of the current view on the left, and a set of buttons on the right that are used to change the current view. The different views available are detailed in the following table, and each view is described in detail in subsequent sections.

Menu Item	Description
Map View	Displays a map view of the network and site motion statistics.
Nav View	Displays a navigation view of the network, for configurations with multiple antennas affixed to a moving body.
All NEU	Displays horizontal scatter and vertical histograms for multiple sites. Display for up to six sites will appear in the Screen Graphics Window with this view selected. If more than six sites are present in the network, a "Next" button will be present which allows paging between the All NEU views of sets of sites in the network.
All Tropo	Displays the troposphere zenith delay parameters for each site. As with the All NEU view, this view displays graphs for up to six sites in the network, and allows paging if more sites are present.
PRN Track	Displays a graphic visualization of satellite positions (and GDOP) currently observed by each network site. As with the All NEU view, this view displays graphs for up to six sites in the network, and allows paging if more sites are present.
Alarms	Displays the last 100 alarms generated for this project. Alarms are error conditions that have occurred, such as inability to communicate with a receiver or the calculated position of the receiver being outside a user defined threshold.
Statistics	Displays the last site coordinate statistics for this network. Statistical information (median and IQR) is calculated for sets of calculated positions at user-defined intervals. This window gives detailed information on the most recent statistical calculations of network geometry.
Baselines	Displays detailed graphs with the scatter in each coordinate component and horizontal (North vs. East) scatter for an individual site, as well as statistically corrected scatter as calculated at both a user defined time intervals and daily. Alternatively, displays positions, velocities, and accelerations of moving objects when Velocity option is set in Tool Bar or View Menu.

Table 3 – Screen Graphics Window Menu

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4.1 Screen Graphics: Map View (Useful for Static Mode Only)

The screen graphics map view allows the user to see a map view of the network based on the *a priori* (reference) site coordinates. The left side of the screen displays the geographical topology of the sites in the network, and optionally horizontal (north-east) long-term shift. Display of shift in the left side of the map view is toggled with the toolbar checkbox “Map Data”. The right side of the screen gives a more detailed iconic display of long-term movement trends of each site in the network, useful for static sites. The long term trends are based on statistical daily medians for each site, with the start and end date for which movement trend is to be displayed being user selectable.

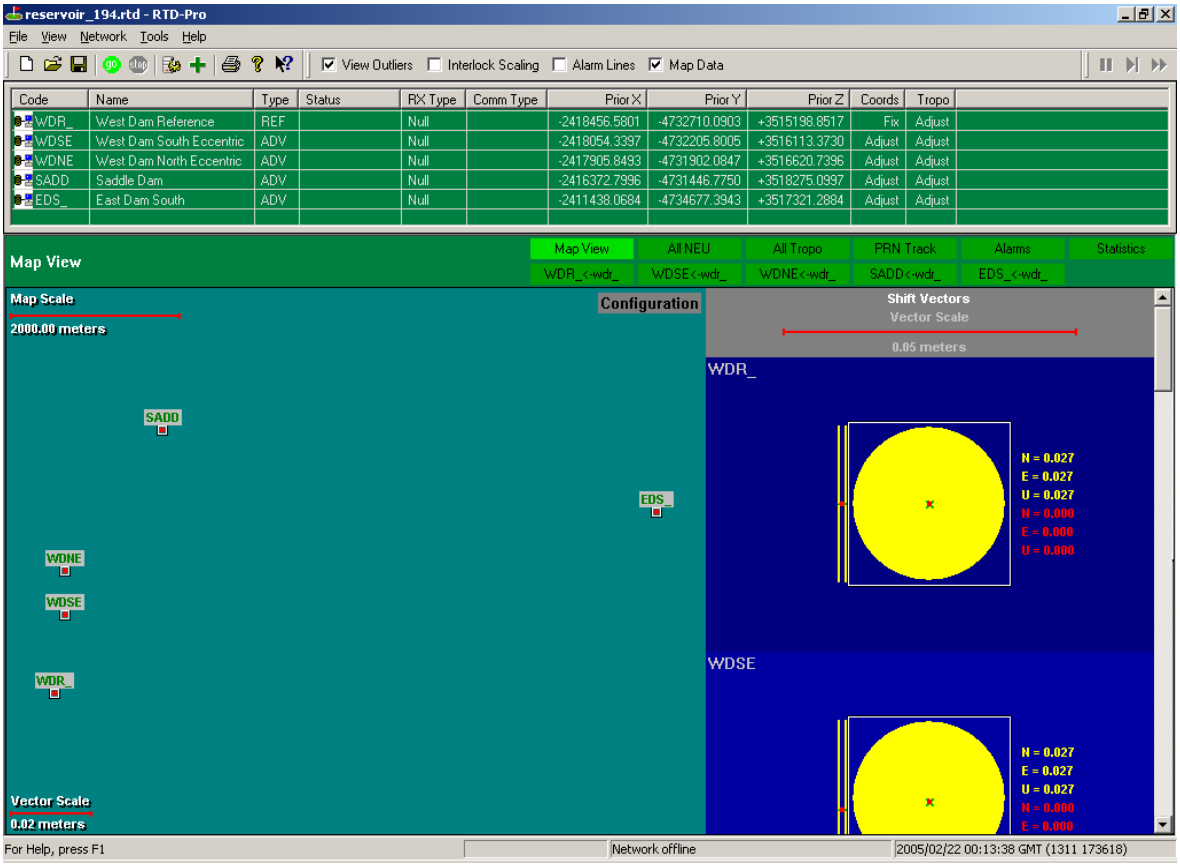

Figure 9 – Screen Graphics: Map View

Horizontal (north-east) shift in the map section of the map view is simply denoted by a red line originating from a small red dot for each site. Length and direction of the red line indicates magnitude and direction of shift over the selected time period. All shift lines are scaled per the legend in the lower left corner. The red dot indicates the position of the site relative to shift at the start of the selected period.

Clicking on the Configuration box in the upper right corner of the map will access the Map Vector Configuration dialog (see below) and allow the user to adjust shift vector scaling and to denote start and end dates for computing site shifts.

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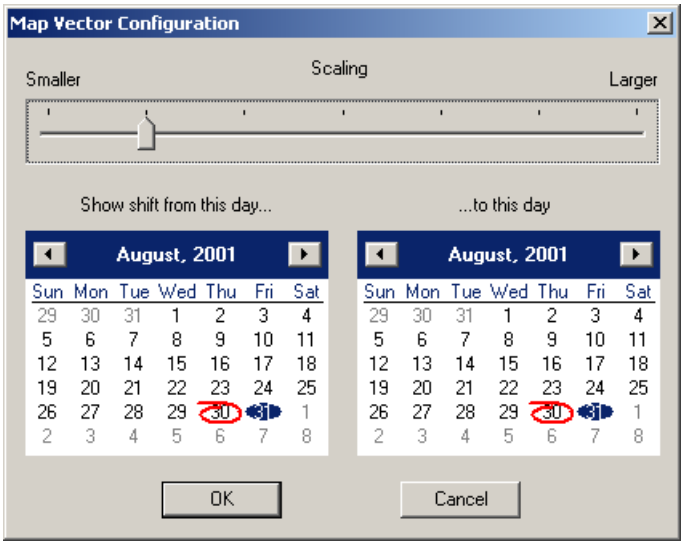

Figure 10 – Map Vector Configuration (example)

The detailed iconic shift information list on the right side of the map view displays the following information for each site (if the information is available for the site):

(1) The true coordinate values in horizontal (N,E) and vertical (U) coordinates (denoted by green X's).

(2) The shift vectors in horizontal (N,E) and vertical (U) coordinates (denoted by red lines). The dot on one end of the red line denotes the calculated position at the start date; the other end denotes the calculated positions at the end date.

(3) The value of NxIQR, where N is an integer multiple defined by the user (default is N=4) denoted by a yellow line for U and an error ellipse for (N,E). The ellipse axes are scaled by the value of N.

(4) If Map Data is toggled on, the vector shifts are also displayed. Numbers in green (on top) indicate the change in position of the site at the end date relative to the a priori coordinates for the site (displayed in the Site Window). Numbers in red (on bottom) indicate the shift in position between the two dates specified in the Map Vector Configuration dialog.

The Map View contains two scales, the Map Scale and Vector Scale. The vector scale can be modified in the Map Vector Configuration dialog.

Note: The user can input an actual map as a backdrop to this site map view via the Network Configuration/Graphics property page.

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4.2 Screen Graphics: Nav View

The navigation view replaces the map view when attitude determination is used. Attitude determination is enabled in the advanced section of network configuration. When two antennas are mounted on a moving body in a known configuration, pitch and heading of the body can be determined. Addition of a third antenna allows roll to be determined also. If attitude determination is being used, this view gives a graphical overview of the body to which the antennas are mounted. The top left graph gives a ground track with latitude and longitude reference lines of the most recent 300 epoch positions. The bottom left graph displays height in meters for the most recent 300 epoch positions. The top right is a compass ribbon, which displays current heading. And the bottom right is an attitude indication display, which shows current pitch and roll of the body.

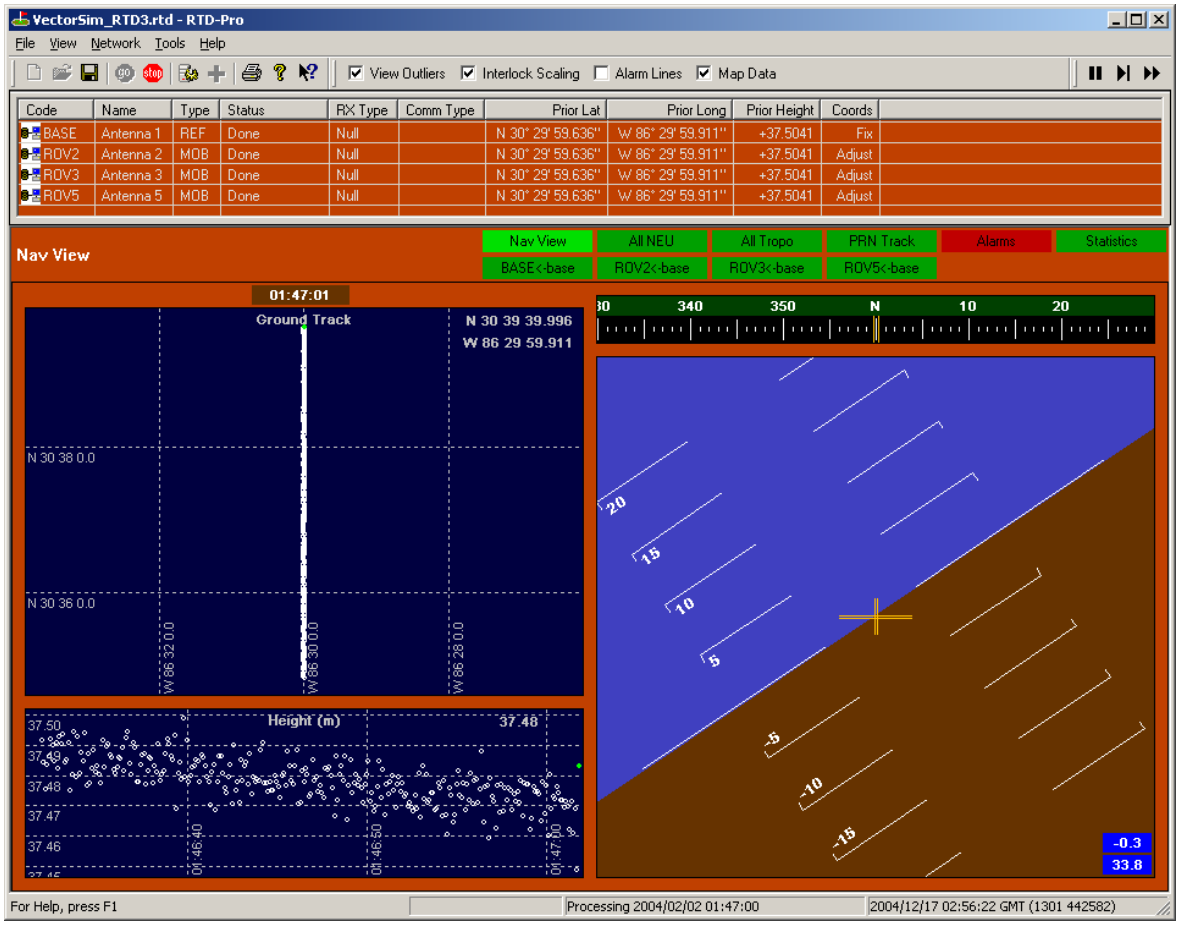

Figure 11 – Screen Graphics: Nav View

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4.3 Screen Graphics: All NEU

The All NEU (North, East, Up) screen graphics command allows the user to simultaneously display horizontal scatter plots and vertical histograms for multiple sites.

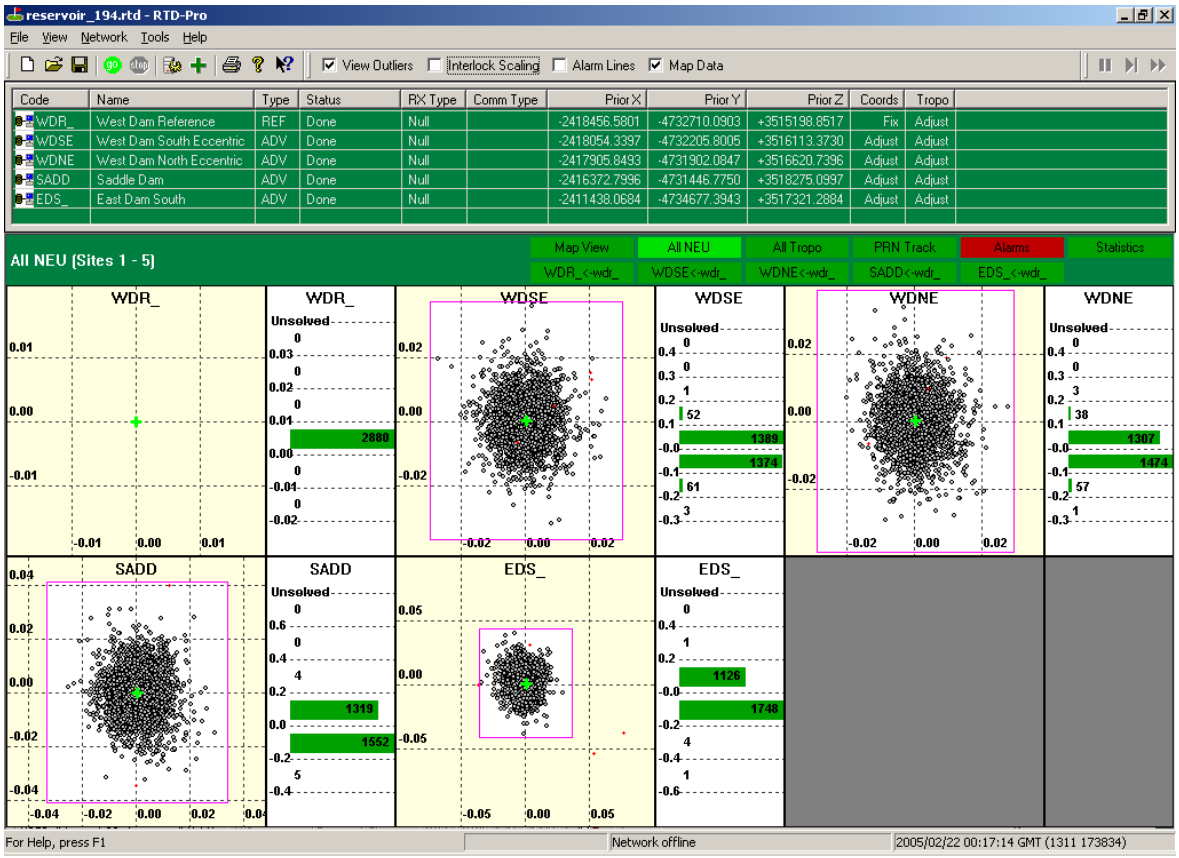

Figure 12 – Screen Graphics: All NEU

GeoRTD can display 6 sites per page. If the number of sites exceeds six, then a “Next Page” button will appear to allow scrolling through the sites.

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4.3.1 Legend for Horizontal Scatter plot:

Each point displayed on the horizontal scatter plots represents a single-epoch solution. The scale of the axes is in meters.

- Black circles denote good single-epoch solutions.
- Red crosses denote single-epoch outliers.
- The **magenta lines** around the plots denote the N*IQR threshold. Points that fall out of this box in any axis (X, Y, or Z) are flagged as outliers.
- The median value for the horizontal scatter is denoted by a green **(+)**.

4.3.2 Legend for Vertical Histogram:

The scale of the vertical axis is in meters. Green bars in the horizontal direction display the number of solutions that fall between each pair of vertical gridlines graphically. The number of non-solutions is displayed as an orange bar above the vertical axis (under Unsolved).

4.3.3 Display Options:

Display of Outliers in the horizontal scatter plots can be controlled using the **View Outliers** check box (located to the right of the toolbar). If the box is checked, then outliers will be displayed. For more information refer to section 4.9.1.

You can force GeoRTD to use the same scale for the vertical axes on all plots for a site by checking the **Interlocked Scaling** box (located to the left of the toolbar menu). For more information refer to section 4.9.2:

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4.3.4 Zoom View:

The user can zoom in on any plot by clicking on the plot with the left mouse button, and zoom back out with another click. When a plot is zoomed, it will occupy the entire screen graphics area.

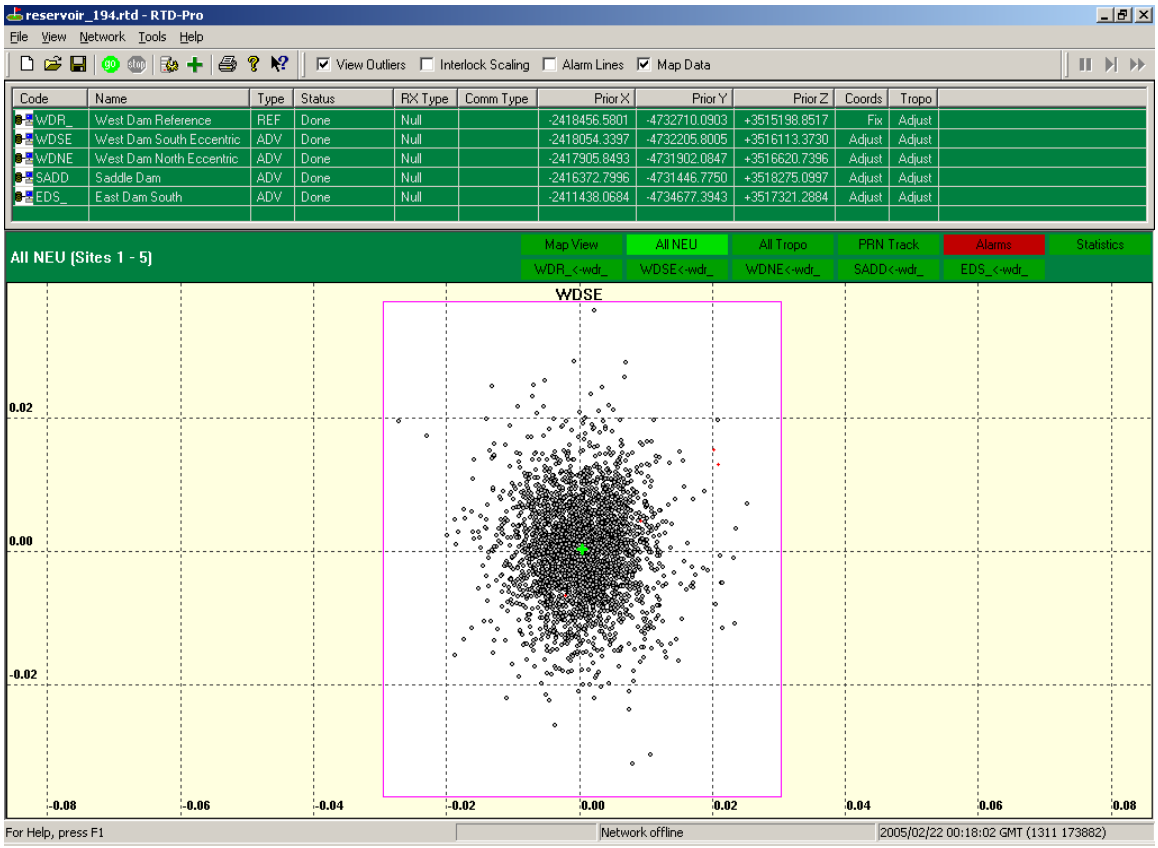

Figure 13 – Screen Graphics: Zoom on the horizontal scatter for one site

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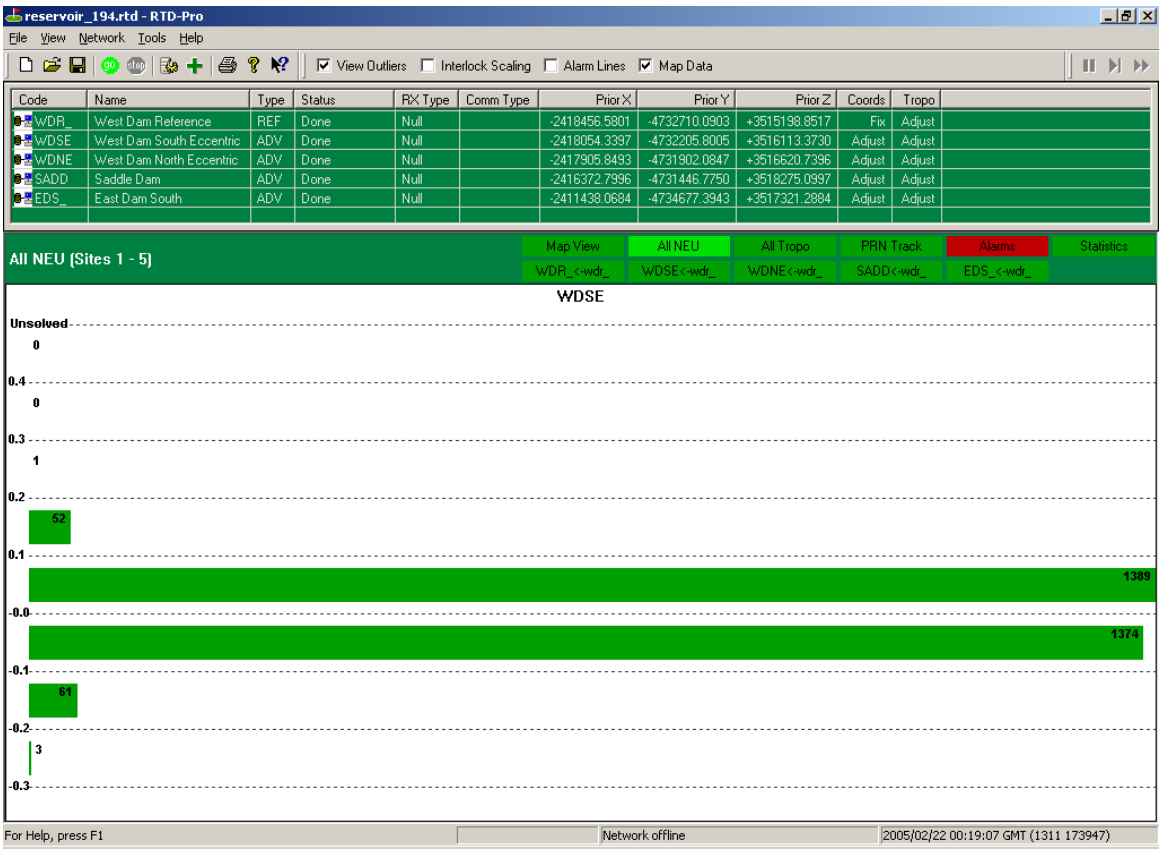

Figure 14 – Screen Graphics: Zoom on the vertical histogram for one site

4.4 Screen Graphics: All Tropo

The All Tropo screen graphics command allows the user to display the troposphere zenith delay parameters for each site. This dialog is only meaningful when zenith delay parameters are adjusted, or if the user is interested in the magnitude of the *a priori* troposphere delay parameters.

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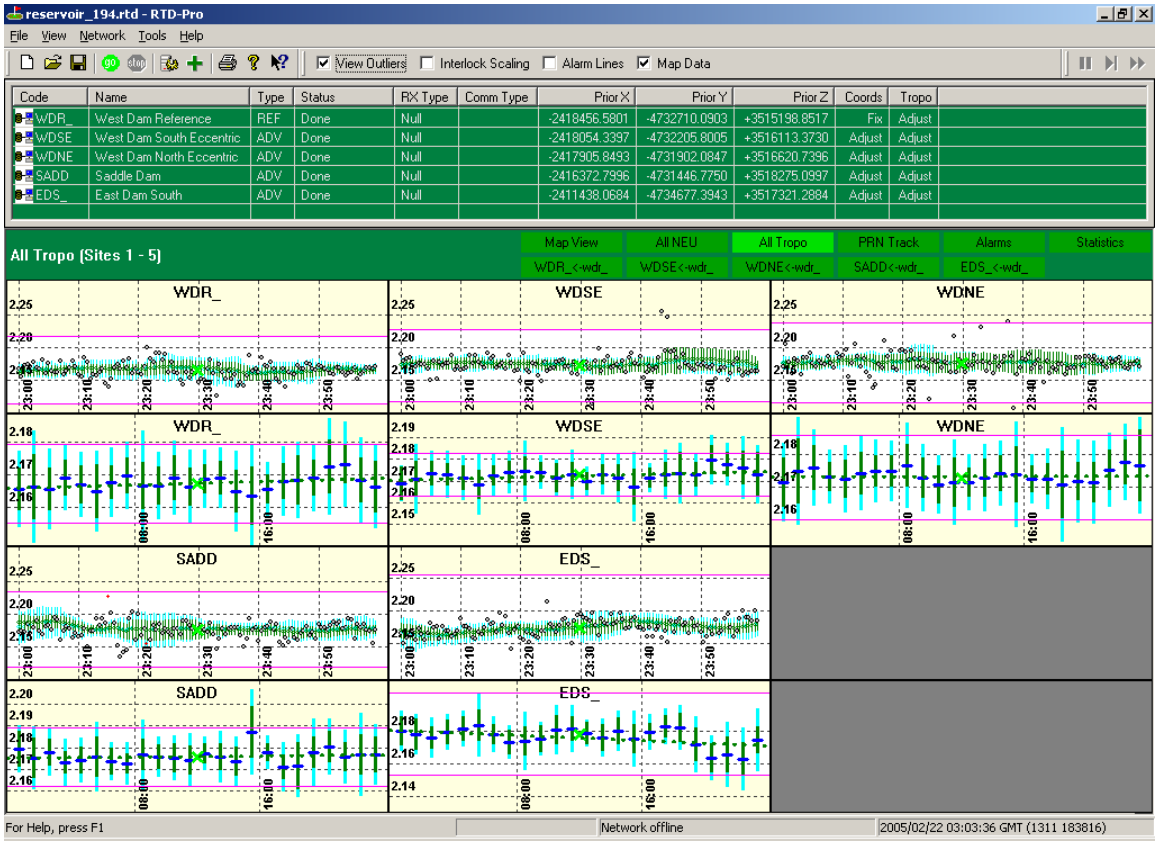

Figure 15 – Screen Graphics: All Tropo

Parameters will be displayed for all sites, including the Master Site. If the zenith delay parameters are fixed at the Master Site, it's *a priori* values will be displayed rather than adjusted values.

GeoRTD can display 6 sites per page (including the Master Site). If the number of sites exceeds 6, then GeoRTD will display the Next Page button, which allows the user to toggle between pages on the Screen Graphic window.

4.4.1 Description of Troposphere Plots:

The parameter display consists of two plots for each site. The upper plot presents the zenith delay parameters estimated every epoch. Each point displayed represents a single-epoch solution for the troposphere delay parameter (vertical axis, in meters) estimated at that site. The horizontal axis denotes time. The lower plot site shows only the median values (vertical axis, in meters) at the user-specified interval.

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4.4.2 Plot Legend:

Upper Plot:

- Black circles denote good single-epoch solutions.
- Red crosses denote single-epoch outliers.
- Orange tick marks represent non-solutions.
- The median value for single-epoch solutions is denoted by a green **(+)**.

Lower Plot:

- The median value for each interval is denoted by a blue **(X)**.
- The median value for this 24-hour period is denoted by a green **(+)**.
- The **dashed green line** denotes the trend line.

Both Plots:

- The **magenta lines** above and below the plots denote the N*IQR threshold. Points that fall out of this box are flagged as outliers.

4.4.3 Display Options:

Display of Outliers in the horizontal scatter plots can be controlled using the **View Outliers** check box (located to the left of the toolbar menu). If the box is checked, then outliers will be displayed. For more information refer to 4.9.1.

You can force GeoRTD to use the same scale for the vertical axes on all plots for a site by checking the **Interlocked Scaling** box (located to the left of the toolbar menu). For more information refer to section 4.9.2.

Display of alarm thresholds can be controlled using the **Alarm Lines** check box (located to the left of the toolbar menu). If enabled, the alarm thresholds will appear as red lines on the plots. For more information refer to section 4.9.3.

4.4.4 Zoom View:

The user can zoom in on any plot by clicking on the plot with the left mouse button, and zoom back out with another click. When a plot is zoomed, it will occupy the entire screen graphics area.

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4.5 Screen Graphics: PRN Track

The PRN Track screen graphics command allows the user to display a graphical representation (sky plot) of satellites currently visible and tracked by the receiver for each site. The GDOP value for each site is also displayed.

GeoRTD can display 6 sites per page. If the number of sites exceeds 6, then GeoRTD will display the Next Page button, which allows the user to toggle between pages on the Screen Graphic window.

As the satellites move, they will leave a trace indicating their former positions (see example on the Zoom display fig x).

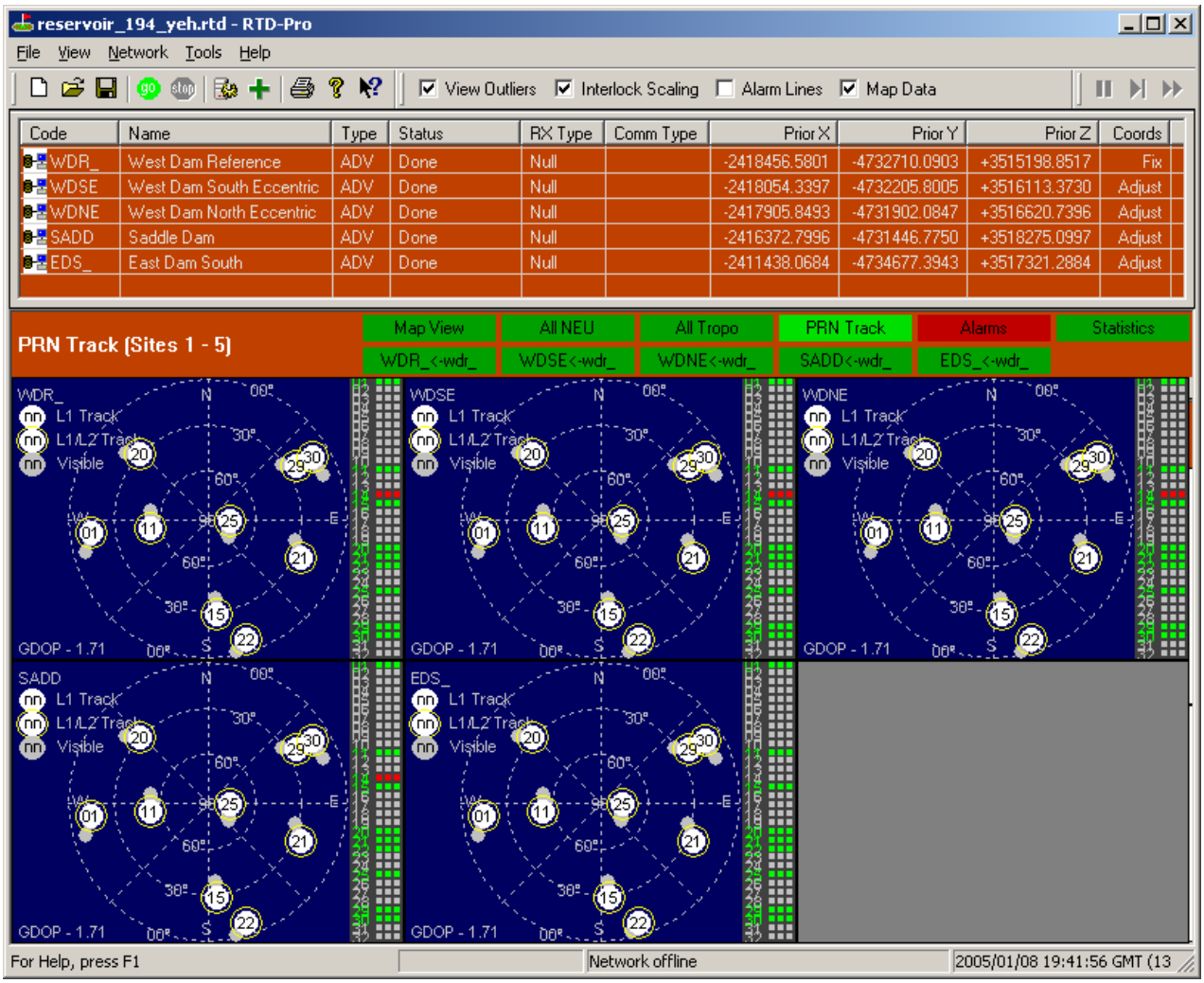

Figure 16 – Screen Graphics: PRN Track

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4.5.1 Description of PRN Track Plots:

All satellites currently visible to the receiver at the site are plotted with respect to azimuth and elevation. A colored circle, labeled with its PRN number, represents each satellite. The instantaneous GDOP value is computed for each site and displayed in the lower left corner of each display.

Satellite Icon	Description
White background	Satellites that are being tracked in single-frequency (L1 only)
Yellow ring surrounding white background.	Satellites that are being tracked in dual-frequency (L1/L2)
Gray background	Satellites that are visible but are not being tracked
Orange background	Satellites in view but not being used in position calculation

Table 4 – Key: PRN Track Plots

On the right hand side of the PRN track for each site is a set of 3 “LEDs” indicating status for each satellite as reported by the GPS receiver.

- The leftmost LED indicates the status of L1 data, the center is for L2 data, and the rightmost is for Ephemeris data as shown in Figure 17.
- GREEN indicates that the associated data is present.
- RED indicates that the associated data is not present.
- GRAY indicates the GPS receiver is not reporting any data for that satellite.

Figure 17 – PRN Track LED’s

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4.5.2 Zoom View:

The user can zoom in on any plot by clicking on the plot with the left mouse button, and zoom back out with another click. When a plot is zoomed, it will occupy the entire screen graphics area.

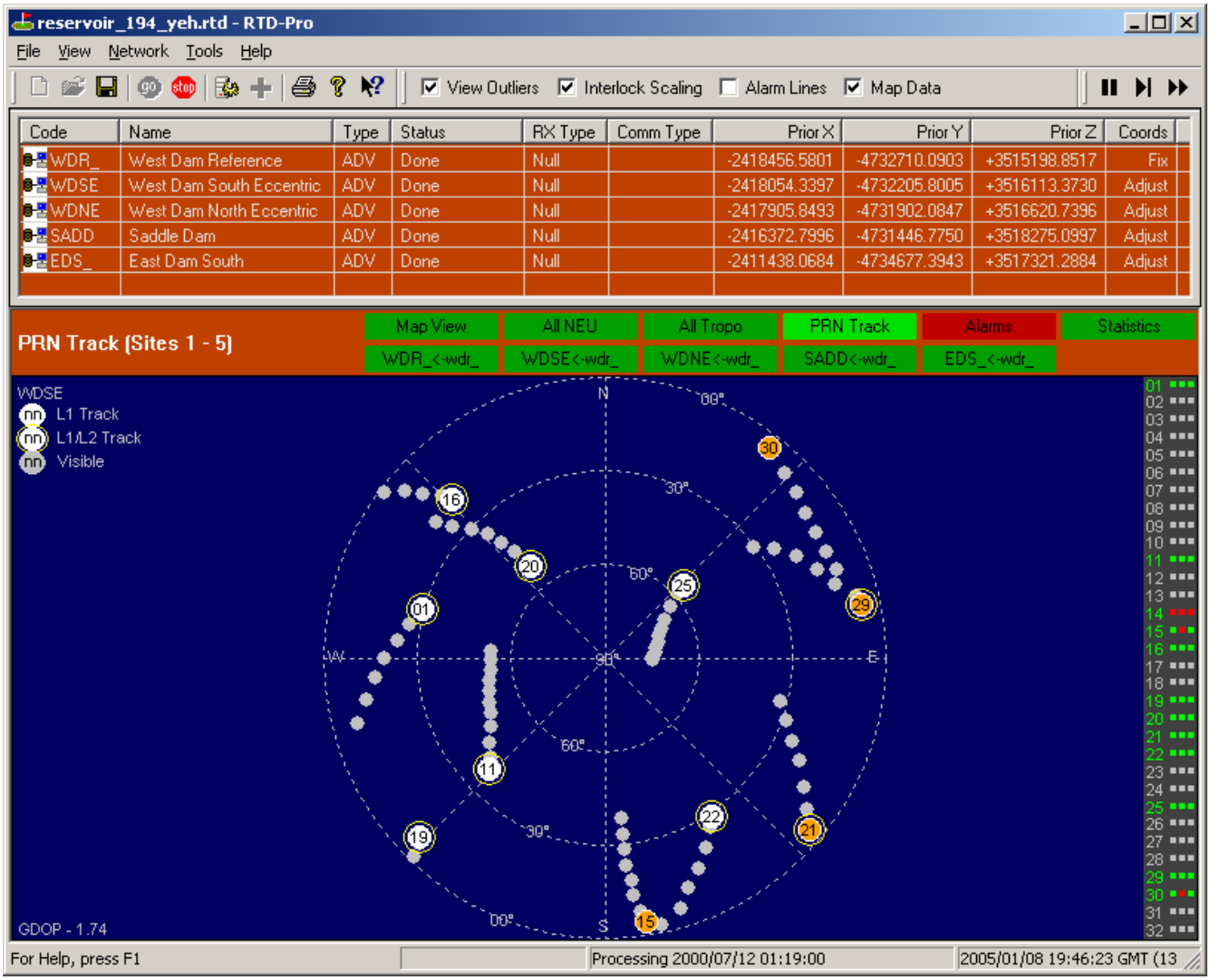

Figure 18 – Screen Graphics: PRN Track Zoom

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4.6 Screen Graphics: Alarms

This window displays the last 100 alarms generated for the project. All alarms are also logged to a file named “cfgname_alarms.txt”, where “cfgname” is the name of the GeoRTD configuration file that generated the alarms. The file name has a time tag appended. This log file will be in a sub-directory name “logs” under the directory containing the GeoRTD configuration file.

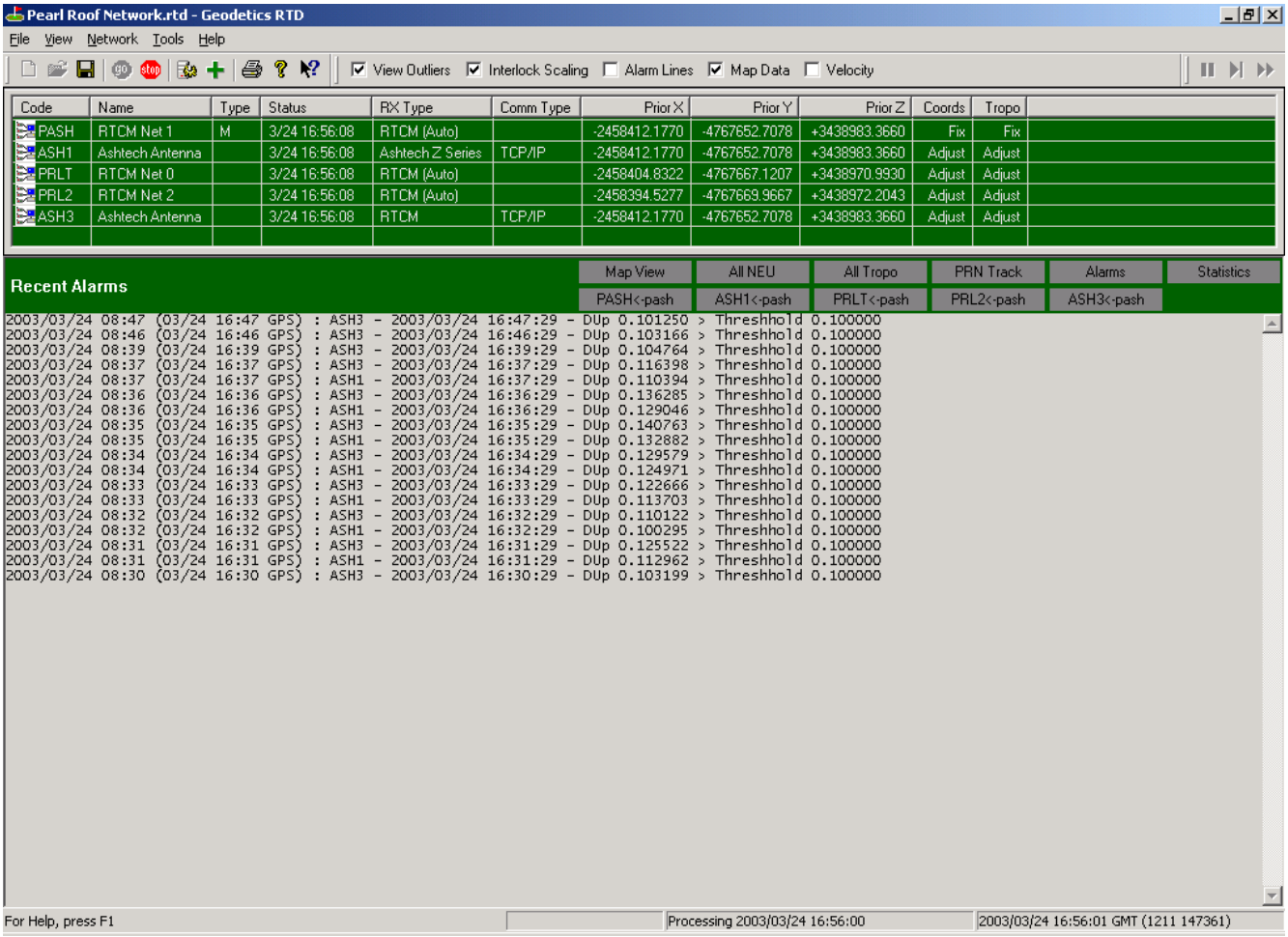

Figure 19 – Screen Graphics: Alarms

Alarms are generated when any of the following occur:

1) No data from a site in a real-time network were received for a user specified number of minutes.

2) Data were received, but no solutions (positions) were determined for a site in a real-time network for a user specified number of minutes (indicating receiver problems or delays in the communications link).

3) Upon connection to a site in a real-time network, the connection was valid but the receiver could not be initialized, it was not responding to commands.

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4) A site in a real-time network that is using TCP/IP to communicate experienced an error and was disconnected.

5) Automatic ftp download of precise ephemeris (SP3) was selected, but GeoRTD was unable to download the current file.

6) The statistical median calculated was outside of the user specified tolerance.

7) The outlier count was exceeded during calculation of daily statistics, i.e., the data are of too poor quality to calculate meaningful statistics.

8) No files were found for a site for a post-processing session.

9) No ephemeris was found for a post-processing session.

10) A file in the data directory for post-processing was ignored. This is normal because it was an unknown file type or wasn't associated with any site in the network.

11) Errors were encountered translating a file during post-processing.

12) A file transfer procedure failed.

13) The license period set in the security key is within two weeks of expiration.

14) A hard drive where data are being stored has filled past a user specified threshold.

15) The user selected the menu item "Tools/Generate Alarm". This feature allows the user to test the alarm to email setup.

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4.7 Screen Graphics: Statistics (Useful for Static Mode Only)

This window displays the last site coordinate statistics for the network. Statistics are also logged to a file named “cfgname_stats.txt” ”, where “cfgname” is the name of the GeoRTD configuration file which was running when the statistics were calculated. The file name has a time tag appended. This log file will be in a sub-directory name “logs” under the directory containing the GeoRTD configuration file. An entry to the statistics file is generated every time a median value is computed for an interval of single-epoch solutions. For more information on choice of median time interval refer to section 5.4.

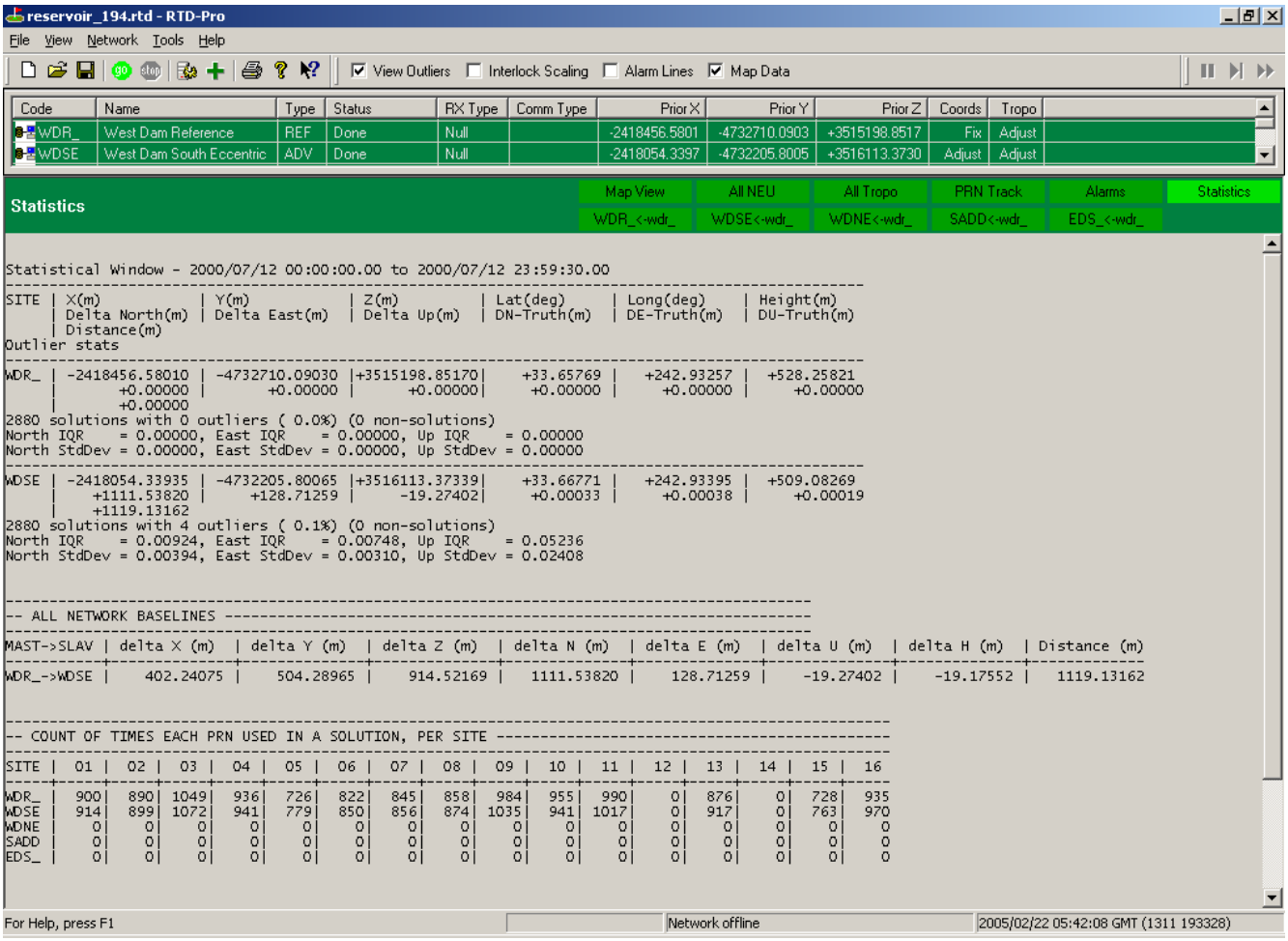

Figure 20 – Screen Graphics: Statistics Display

The statistics display and statistics file contains the time span of the median solution and the following information for each site:

- Adjusted ITRF X,Y,Z values (meters). The Master Site will display its prior values.
- Adjusted WGS84 Geodetic latitude, longitude, and height (decimal degrees, meters). The Master Site will display its prior values.
- Topocentric N,E,U values relative to Master or Reference site (meters). Zero values will appear for Master Site.

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- Topocentric N,E,U values relative to a priori values, i.e. the adjusted values (meters). Zero values will appear for Master Site.
- Total number of single-epoch solutions within the time interval.
- Number and percentage of single-epoch outliers within the time interval. For more information on outliers refer to section 4.9.1.
- Number of non-solutions. These are single-epoch solutions rejected by GeoRTD.
- IQR values in terms of North, East, and Up components.
- Table of PRN use statistics.
- Optionally, baseline information for all pairs of sites in the network.

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4.8 Screen Graphics: Baselines

The baselines screen graphics view allows the user to display the single-epoch solutions for individual sites. The solutions can be plotted for the site itself (stand-alone), or in relationship to another site (baseline). The method of display is set on the “Graphics” window in network configuration. If a site is plotted stand-alone, solutions are plotted in reference to the truth position for the site. If the site is plotted in baseline mode, GeoRTD displays the position of a site relative to a baseline to another site, referred to as a *reference* site. This pair of sites is referred to as a *baseline*. The reference site for each site, the Master Site by default, may be changed in the site properties. For example, suppose that a baseline consists of the Master Site called SIT1 and another site called SIT2. The baseline vector between SIT1 and SIT2 will be displayed at SIT2<-SIT1, meaning that the baseline denotes the relative position of SIT2 relative to SIT1. The origin of the baseline vector is SIT1 and it points in the direction of SIT2.

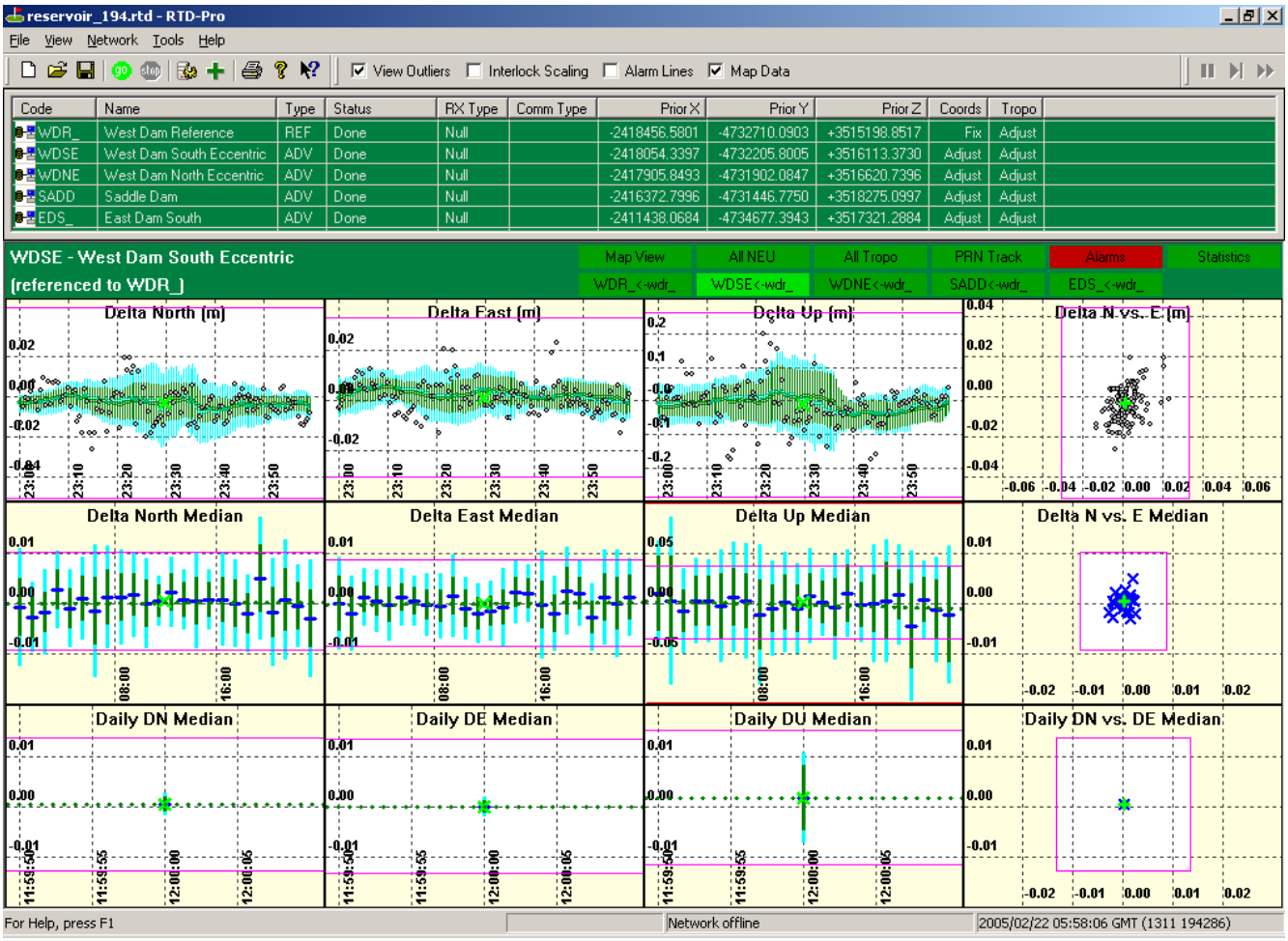

Figure 21 – Screen Graphics: Baseline Plots

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4.8.1 Description of Plots:

The Baselines display consists of (left to right) a set of three plots for each of the baseline coordinate components (Delta North, Delta East and Delta Up), as well as a plot of the horizontal components (Delta North vs. Delta East).

A set of three plots (stacked vertically) for each of the baseline components consists of the following:

For Kinematic/Dynamic Configurations (The location constraint type of the site is set to "Mobile")

- **Baseline components**: The upper plot denotes the baseline coordinate components (vertical axis, in meters) estimated every epoch, with respect to the *a priori* component value. Four panels display the Delta North, Delta East, Delta Up, and Delta North vs. Delta East components. Each point represents a single-epoch solution. The horizontal axis of the upper plot denotes time.
- **Velocities:** The middle plot denotes the velocity components (vertical axis, in meters/second) of the moving (or static) object. Four panels display the North Velocity, East Velocity, Up Velocity, and Composite Velocity. The horizontal axis of the upper plot denotes time.
- **Accelerations:** The middle plot denotes the velocity components (vertical axis, in meters/second/second) of the moving (or static) object. Four panels display the North Acceleration, East Acceleration, Up Acceleration, and Composite Acceleration. The horizontal axis of the upper plot denotes time.

For Static Configuration (The location constraint type of the site is not set to "Mobile")

- **Baseline components**: The upper plot denotes the baseline coordinate components (vertical axis, in meters) estimated every epoch, with respect to the *a priori* value. Each point represents a single-epoch solution. The horizontal axis of the upper plot denotes time.
- **Periodic Medians:** The middle plot shows median values calculated at a user specified sub-24 hour time interval (e.g. hourly).
- **Daily Medians:** The lower plot will display daily median values (in synch with the GPS day).

The rightmost set of three plots show north versus east components in meters, upper for current solutions, middle for periodic medians, and lower for daily medians.

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4.8.2 Plot Legends (for static configuration plots):

Upper Plots:

- Black circles denote good single-epoch solutions.
- Red crosses denote single-epoch outliers.
- Orange tick marks represent non-solutions.
- The median value for the single-epoch solutions is denoted by a green plus sign **(+)**.

Middle plots and lower plots:

- The median value for each interval is displayed as a vertical bar. A blue hash mark in the middle of the bar denotes the median value. The total span of the bar denotes IQR. The background of the bar will be light blue if the median is not an outlier, and light red if the median is an outlier. There will also be a green band centered in the middle of the bar, this denotes standard deviation of the mean value of the set of positions.

Common to all plots (when velocity option not set):

- The median value for all points on the graph is denoted by a green plus sign **(+)**.
- The **magenta lines** above and below the plots denote the N*IQR threshold. Points that fall out of this box are flagged as outliers.
- The **dashed green line** denotes the trend line.
- If alarm lines option is enabled, the alarm thresholds are represented by **red lines**.

4.8.3 Display Options:

Display of Outliers in the horizontal scatter plots can be controlled using the **View Outliers** check box (located to the left of the toolbar menu). If the box is checked, then outliers will be displayed. For more information refer to section 4.9.1.

You can force GeoRTD to use the same scale for the vertical axes on all plots for a site by checking the **Interlocked Scaling** box (located to the left of the toolbar menu). For more information refer to section 4.9.2.

Display of alarm thresholds can be controlled using the **Alarm Lines** check box (located to the left of the toolbar menu). If enabled, the alarm thresholds will appear as red lines on the plots. For more information refer to section 4.9.3.

4.8.4 Zoom View:

The user can zoom in on any plot by clicking on the plot with the left mouse button, and zoom back out with another click. When a plot is zoomed, it will occupy the entire screen graphics area.

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4.9 GeoRTD's Special Graphics Functions

Figure 22 – Special Graphics Functions

4.9.1 View Outliers Option (Useful for Static Mode Only)

Outliers will be displayed when this option is enabled. A check mark next to the View Outliers menu item indicates that the option is enabled. Clicking on the View Outliers box toggles the status of this option.

Small red crosses denote outliers. The outlier range is indicated on the horizontal scatter plots by purple lines. The range is always displayed, independent of the View Outliers option.

Refer to section 2.11 for more information about outliers.

Accessible from View/Outliers menu and View Outliers checkbox.

4.9.2 Interlocked Scaling Option

This option enables interlocked scaling for screen graphics. A check mark next to the menu item indicates that the option is enabled. Clicking on the Interlocked Scaling box toggles the status of this option.

When interlocked scaling is enabled, the vertical axes of the data plots are constrained to have the same scale. Because vertical coordinate precision is considerably less than horizontal coordinate precision, in general, and in particular for single-epoch solutions, the scale of the plots will usually be determined by the scatter in the vertical coordinates.

Accessible from View/Interlocked Scaling menu and Interlocked Scaling checkbox.

4.9.3 Alarm Lines Option (Useful for Static Mode Only)

When the Alarm Lines option is enabled, the upper and lower limits of the alarm threshold for each coordinate (N, E, and U) will be shown on the GeoRTD graphics displays. Red lines depict these alarm thresholds. A check mark next to the menu item indicates that the option is enabled. Clicking on the Alarm Lines box toggles the status of this option.

The alarm thresholds are defined by the user on the Network Configuration Statistics dialog.

Note: Alarm lines may be displayed even if the "Alarm Lines" option is disabled, enabling the "Alarm Lines" rescales the graphs to insure that both alarm lines and solutions are both visible even if solutions are out of the alarm band.

Accessible from View/Alarm Lines menu item and Alarm Lines checkbox.

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4.9.4 Map Data Option

This option controls whether GeoRTD will display shift (displacement) data for sites in the main part of the map view. Refer to the description of the map view window for more details. A check mark next to the menu item indicates that the option is enabled. Clicking on the “Map Data” box toggles the status of this option.

Accessible from View/Map Data menu item and Map Data checkbox.

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5.0 GeoRTD Network Configuration

The Network Configuration window has several different property pages (menus), with each page controlling a different aspect of the overall network. Each network type has property pages specific to it, although some property pages are common to several network types supported by GeoRTD (Real-time, downloading, Post-processing, GNS viewing). The network configuration window is accessible by selecting “Network/Configuration” or by clicking on the “Configure” toolbar button.

Property Pages	Network Type			Description
	Real-time Network	Post-process	GNS Playback	
Path/Time		X		Time span for post processing.
Processing	X	X		Parameters for Epoch-by-Epoch™ (GPS) network processing
Ephemeris	X	X		Ephemeris (orbit) options
Stats	X	X	X	Statistical reporting options
Alarms	X			Alarm thresholds and email notification options
Graphics	X	X	X	Statistical graphs and background mapping options.
Store	X	X		Data storage options
Manage	X			File management/archive options
Network	X			GeoRTD server options for PIN positioning and network RTK (specific to GeoRTD Pro)
SINEX		X		SINEX output options
GNS File			X	GNS file specification and solution interval
Advanced	X	X		Advanced network options.

Table 5 – Network Configuration Pages

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5.1 Network Configuration: Path/Time Property Page

Use this dialog to configure post-processing. A path to the files to be processed is set on this tab, and it may be a single directory or a directory sub-tree. The time span to be processed must be specified, and also a file-to-site association rule. GeoRTD associates data files to the appropriate site by matching the site code of the site to a subset of the file name, so the site code must appear somewhere in the file name. Site codes must be four characters in length. The location of the site code may be anywhere in the file names, and the position in the file name is specifiable on this window. However, the position of the site code in the file name must be consistent for all files to be processed.

When starting post-processing, GeoRTD examines all files in the selected data path. It determines the type of file, which may be any of the formats listed below:

- RINEX
- Leica LB2 or MDB binary formats.
- Ashtech MBEN/PBEN binary formats
- Trimble RT17 format
- Novatel OEM4/OEMV binary formats
- Navcom NCT binary format.
- Topcon GRIL format (using rM message)
- SiRF binary files.

RINEX ephemeris and SP3 precise ephemeris files are also recognized.

After determining the file types of all files in the data path, GeoRTD determines the time span covered, and matches files to site using the site code association. All files of a recognized format associated with a site in the network within the specified time are processed.

Two processing modes are provided, multiple session and single session. Multiple-session mode is useful for processing large amounts (days or weeks) of data spanning equal segments of time, using one GeoRTD configuration; single-session mode provides for processing a single experiment over a user-specified (usually short) duration. For multiple-session mode a separate processing session is performed for each date between and including the specified start and end date. Only data between the specified start and end times is processed for each date/session. In single-session mode, all data between the starting date and time and the ending date and time are processed in a single session. All data for a session is loaded to memory before processing.

Further details for the fields on this page are given on the next page.

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Applicable Network Types: Post-processing

To Access: Select “Network/Configuration” main menu item, or the button on the toolbar; then select the “Path/Time” tab on the network configuration window.

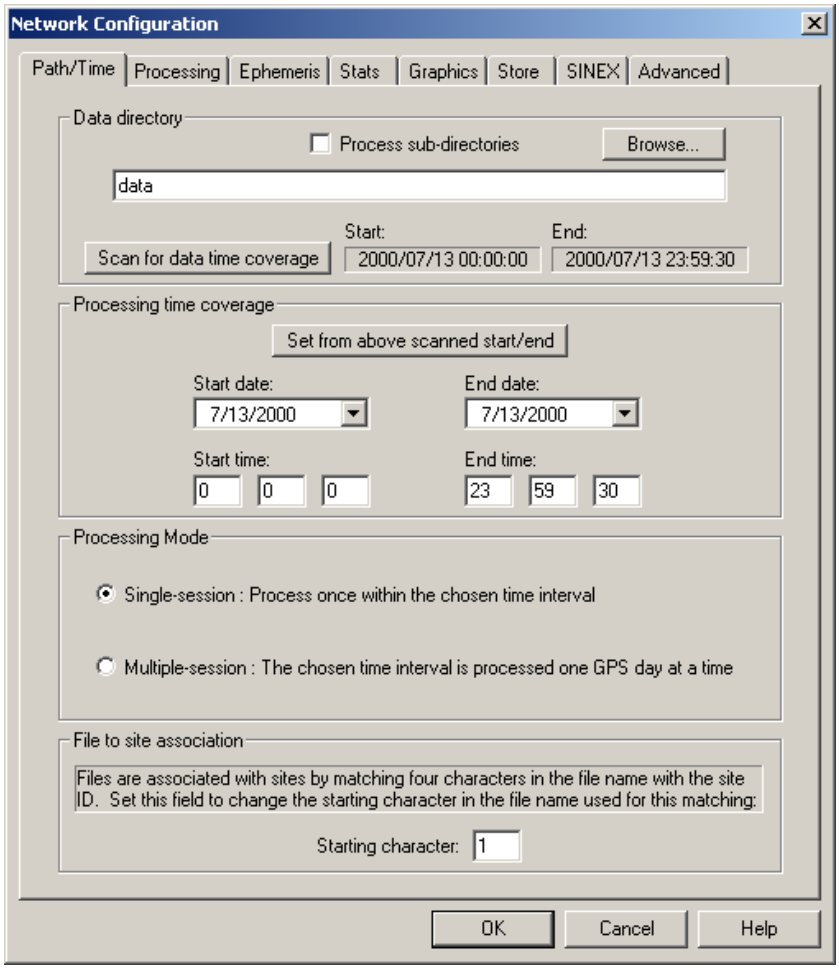

Figure 23 – Network Configuration

Field descriptions:

<u>Data Directory</u>
Enter or browse to the directory containing the files to be processed. If “Process sub-directories” is unchecked, only files in the specified folder are processed. If checked, all files in the specified folder and all sub-folders are processed. The “Scan for data time coverage” button may be used to scan the files to be processed to get the starting and ending observable time representing the data in all files.

<u>Processing Time Coverage</u>
Enter the start date, end date, start time, and end time to be post-processed. How these are used depends on the processing mode selected. These can be set easily from the data scan in the Data Directory menu.

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Processing Mode
Select Multiple-session or Single-session mode.

File to site association
Enter starting character in data file name (e.g., RINEX, RT17), which is the start of the four-character site code, as described in the menu

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5.2 Network Configuration: Processing Property Page

Use this dialog to set processing (analysis) parameters.

Applicable Network Types: Real-time, Post-process

To Access: Select “Network/Configuration” main menu item, or the button on the toolbar. Then select the “Processing” tab on the “Network Configuration” window.

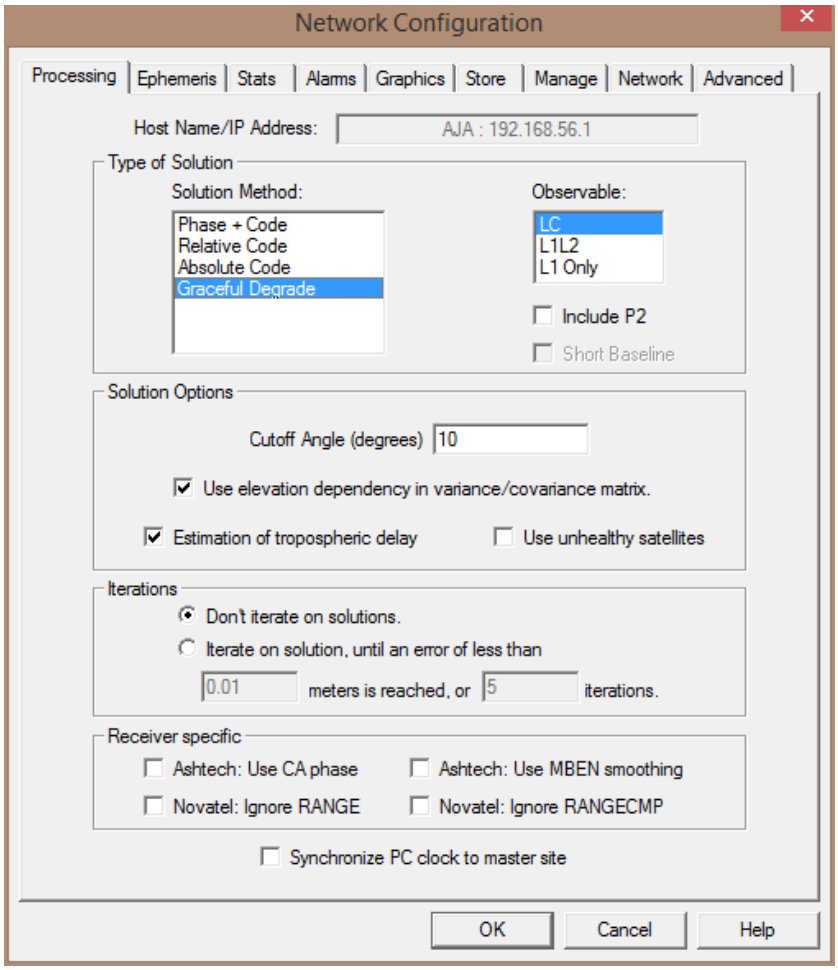

Figure 24 – Network Configuration: Processing

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Field descriptions:

Host Name/IP Address
This field displays the host name and IP address for GeoRTD's computer workstation.

Type of Solution
Solution Method
Use this field to select the desired method for solution calculation

Solution Method	Description
Phase + Code	Use phase and pseudorange measurements
Relative Code	Use absolute and relative pseudorange measurements
Absolute Code	Use only absolute pseudorange measurements
Graceful Degrade	Graceful Degradation guarantees that the position computed for the target object at any instant of time (epoch) is of the highest accuracy and reliability obtainable from the available satellite data. The following are levels of degradation, starting with the best scenario: **Level 1:** Dual-frequency (L1 and L2) phase and pseudorange (code) measurements. **Level 2:** Level 1 but only L1 phase and pseudorange measurements **Level 3:** Level 1 but only L1 and L2 pseudorange measurements. **Level 4:** L1 and L2 phase and pseudorange measurements at the roving object(s). In this case the communications link to the reference station is severed. The software reverts to absolute (point) positioning mode. **Level 5:** Level 4 but only L1 and L2 pseudorange measurements. Note: The best results (highest accuracy) are obtained when both L1 and L2 pseudorange and carrier phase measurements are available from at least 5 visible satellites common to the fixed reference station(s) and moving object(s). As less information is available, the accuracy and reliability degrades.

Table 6 – Processing: Solution Methods

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Observable
Use this field to select the desired method for parameter estimation.

Observable	Description
LC	If LC is selected, the parameters are estimated using the ionosphere-free (LC) phase combination and pseudoranges. Use LC when baselines are longer than a few kilometers.
L1L2	If L1L2 is selected, the parameters are estimated using uncombined L1 and L2 phase measurements and pseudoranges.
L1 Only	If L1 Only is selected, the parameters are estimated using only L1 phase measurements and pseudoranges.

Table 7 – Processing: Observables

Solution Options

Cutoff Angle (degrees)
Use this field to choose an elevation angle cutoff and elevation angle dependency in forming the variance/covariance matrix of observations.

GPS observations are less precise at low elevation angles, in particular because of the increased effects of tropospheric refraction and the uncertainty in zenith delay mapping functions at low elevations. Setting an elevation angle cutoff and down-weighting observations at low elevation angles are meant to compensate somewhat for the high correlations between zenith delay parameter estimates, vertical coordinate estimates, and antenna multipath effects.

Most modern receivers can track satellites to low elevation angles. We recommend a 10 degrees elevation angle cutoff and the use of the elevation dependent weighting model.

Use elevation dependency in variance/covariance matrix
Check this box to reduce weights for observations to low elevation satellites; otherwise all observations will be weighted equally.

Estimation of tropospheric delay
Check this box to enable estimation of troposphere delay parameters. These should be estimated for baselines longer than a few kilometers.

Use unhealthy satellites
Check this box to force the use of unhealthy satellites (designated by PRN number). The GeoRTD default is to ignore observations from unhealthy satellites.

Iterations
These options enable iteration on coordinate parameter adjustments and specification of iteration limits.

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GeoRTD starts with user-specified *a priori* values for site coordinates. Adjustments are estimated for these parameters independently at each epoch by means of a linearized least-squares algorithm. The user can specify that the adjustment be repeated (iterated), either a certain number of times or until the adjusted values are within a certain threshold. On the other hand, if the adjustments are expected to differ only slightly from the *a priori* values (e.g., with a multi-site base network) it is more efficient not to iterate.

Receiver Specific

Global options associated with specific receivers and protocols.

Use CA phase:

Ashtech MBEN messages provide an L1 frequency phase measurement for both the L1 carrier and C/A code. By default GeoRTD will use the L1 phase. Enable this option to use the CA code phase instead.

Apply MBEN Smoothing:

Ashtech receivers provide a smoothing correction for pseudoranges. Select this option to apply this smoothing correction.

Synchronization

(Real-time Network Only) Use this option to synchronize the PC (system) clock using observations from the master site.

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5.3 Network Configuration: Ephemeris Property Page

Use this dialog to control the source of the ephemeris data for the network and to choose which satellites are to be used in the solution.

Applicable Network Types: Real-time, Post-process

To Access: Select “Network/Configuration” main menu item, or the button on the toolbar; then select the “Ephemeris” tab on the network configuration window.

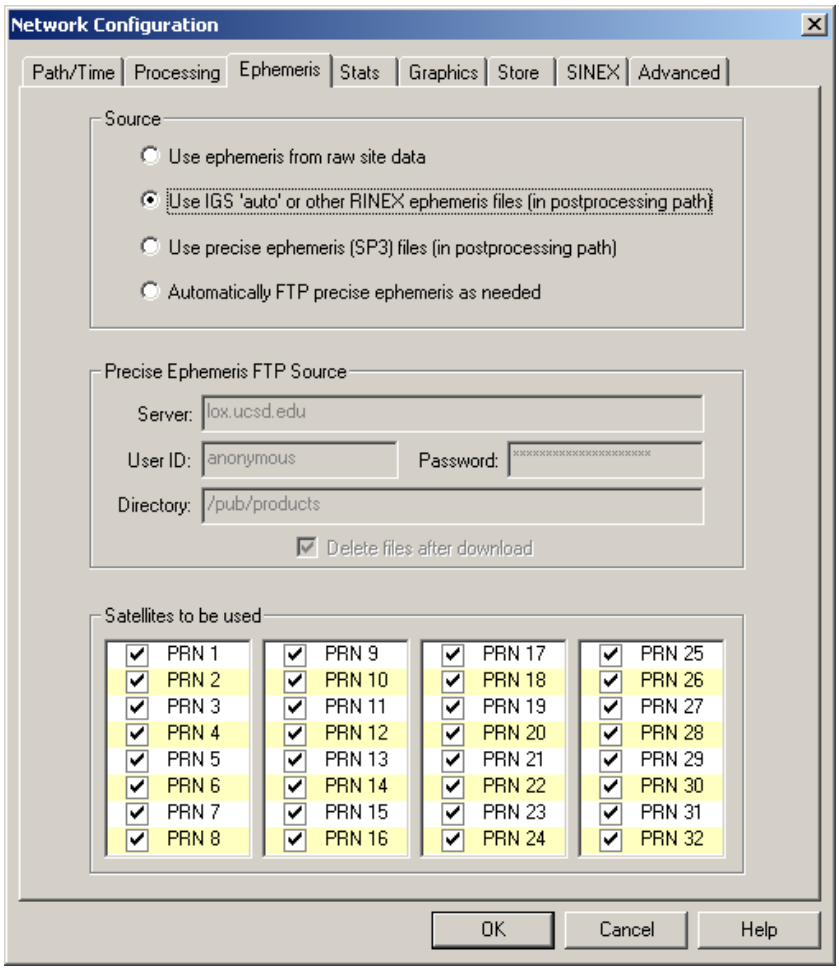

Figure 25 – Network Configuration: Ephemeris

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Field descriptions:

Source

This menu section is used to select between one of four sources for the ephemeris (orbit) information used in the network solution:

Option 1: Use the broadcast ephemeris from the satellites and collected at the individual sites.

Option 2: Use an International GPS Service (IGS) 'auto' files or other RINEX ephemeris file with .yyn extension (where yy is the last two digits of the year).

Option 3: Use an IGS precise ephemeris files in SP3 format.

Options 2 and 3 are valid for post-processing only. When using Options 2 or 3, GeoRTD will detect all files of the specified type in the post-processing data directory and use them if they are applicable to the timespan being processed.

IGS ephemeris files can be obtained from the IGS Central Bureau at ftp://ftp.igs.org/pub/gps/latest/ or from one of the IGS Global Data Centers.

When using IGS SP3 files, the tabular elements must exceed the interval of observations by at least 2 hours before the first observation epoch and 2 hours after the last observation epoch. The data in the SP3 files contain coefficients in 15-minute intervals, but these coefficients are used in a polynomial series, which requires the prior and following 8 coefficient blocks to interpolate satellite position & velocity. So 8 * 15 = 2 hours, thus each 15-minute interval in the SP3 file actually requires the prior and following 2 hours of data. Given this, a single SP3 file with coefficient data from 0:00 to 23:59:59 is actually usable from 2:00 to 22:00. Therefore, when processing 7 consecutive days of data, for example, GeoRTD requires 9 24-hour SP3 files in the post-processing path. It is typical for users of IGS precise orbits to concatenate several SP3 files since surveys often cross the GPS day boundary. GeoRTD is capable of deciphering concatenated SP3 files.

Option 4: Automatically FTP precise ephemeris files for use in Real-time (streaming), or post-processing networks.

Currently, the only FTP site that can be used with this feature is the Scripps Orbit and Permanent Array Center (SOPAC) site (ftp://garner.ucsd.edu). The default directory options for this feature are set to those required for accessing the SOPAC site. Note: SOPAC does not guarantee the availability or accuracy of this data.

GeoRTD automatically chooses the most precise orbit available from the SOPAC site, with the highest priority given to IGS final products, and lowest priority to SOPAC ultra-rapid orbits computed hourly.

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The “Delete file after download” option controls whether the FTP’d files are deleted from local storage once processing is complete. Otherwise, the files are stored in a subdirectory named “ephemeris_cache” below the directory containing the GeoRTD executable.

Satellites to be used

GeoRTD will default to using all satellites. Uncheck a satellite’s PRN number to exclude it from the solutions.

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5.4 Network Configuration: Statistics Property Page

Use this dialog to set statistical processing and display parameters. Note: When positioning moving objects select “Suppress statistics generation.”

Applicable Network Types: Real-time, Post-process

To Access: Select “Network/Configuration” main menu item, or the button on the toolbar; then select the “Stats” tab on the network configuration window.

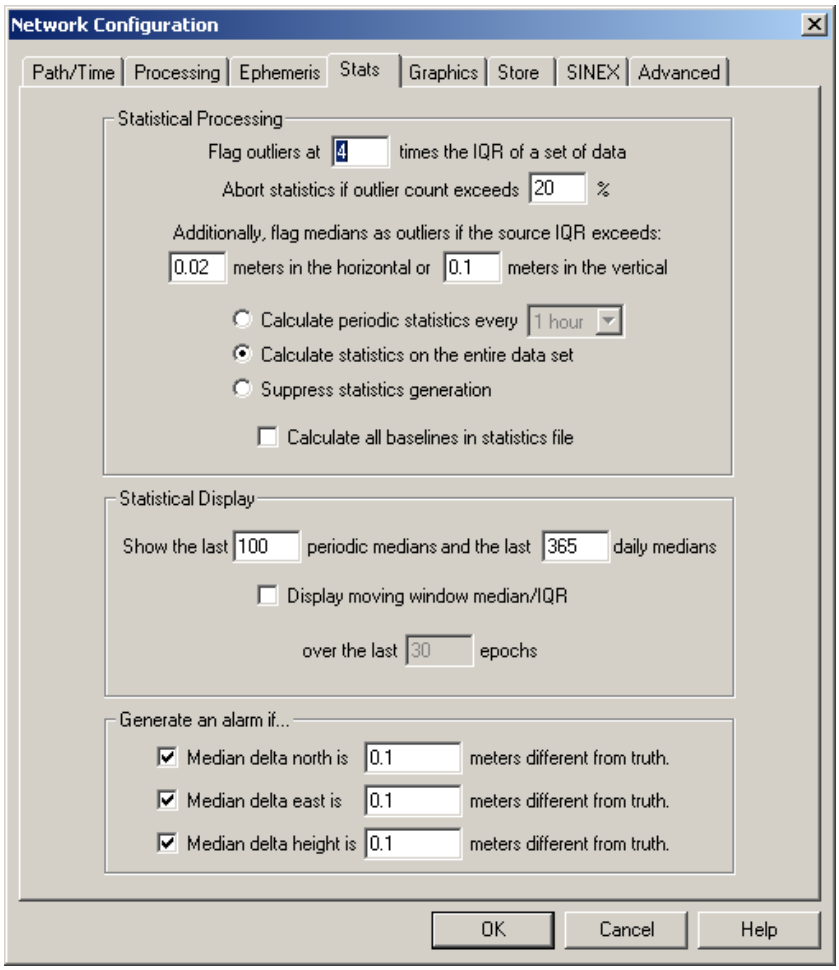

Figure 26 – Network Configuration: Statistics

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Field descriptions:

Statistical Processing

Use these fields to define the interval at which medians are computed, if at all, and how medians are computed.

Flag outliers at...

The user can define the outlier criterion as an integer multiple of the IQR. The default and recommended value is 4 times the IQR (which corresponds approximately to 3-sigma for a normal distribution).

Refer to section 2.11 "The meaning of outliers in GeoRTD (Static Mode Only)" for more information about outliers.

Abort Statistics….

If too many outliers are detected while calculating statistics, as based on the IQR multiple specified, the data are considered invalid and no statistics are calculated. You may control the percentage of outliers at which statistical calculation is aborted; the default is 20%.

Additionally flag medians as outliers…

This additional qualifier can be used to flag medians as outliers if the IQR exceeds the user specified horizontal and vertical values.

Statistics Interval options:

GeoRTD computes site coordinates independently for each network epoch. The user can specify with these settings that a periodic median value be computed at set intervals, where the interval can span from 30 seconds to 24 hours. At the specified time interval, GeoRTD will compute the median of all current epoch solutions. It will then store the medians in a database and add them to the periodic median graphs, and clear the individual epoch solutions. The median values are displayed on the middle baseline plots and are denoted by blue X's. GeoRTD will also compute a median of the periodic medians once per day. The daily medians are displayed on the bottom row of baseline plots.

The user can also choose to compute statistics on the entire data set or to suppress the generation of statistics entirely (these options are not available in real-time streaming mode).

Calculate all baselines...

By default, GeoRTD includes baseline information between each site and its reference site in the statistics file. If this box is checked, GeoRTD will also compute the baselines between each site and every other site in the network and include these in the output statistics file.

Statistical Display

These two fields are used to specify the total number of most recent medians to be displayed at any one time on the median screen plots. There is a setting for the periodic (short term) median graphs and for the daily median graphs.

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The moving window median/IQR option will cause a statistical calculation to be performed on the last “n” Epoch-by-Epoch™ positions calculated for a site. The results are displayed on the top row of graphs in individual site baseline view where real-time positions are plotted. When this option is enabled, the moving window median and IQR is displayed on the real-time graphs at each epoch in addition to the instantaneous position. These are plotted similarly to longer-term statistics, as vertical bars with center point denoting the median, light blue background denoting IQR, and inner green band denoting standard deviation (of the mean).

Generate an alarm if

The alarm for each coordinate component (north, east, height) can be enabled by checking the associated box. The threshold value for each coordinate median can be specified in units of meters.

If a median value differs from the *a priori* parameter value by the user-specified alarm threshold in either the north, east, or height coordinates then an alarm is triggered. The alarm threshold is denoted by dashed red lines in the median screen plots. In the event of an alarm, a log file beginning with “cfgname_alarm” (where “cfgname” is the name of the GeoRTD configuration file) is updated with a time and description of the alarm event. The filename has a date attached to it. This file can be accessed either with a text editor, or by clicking on the Alarms box above the graphics display. GeoRTD saves the last 100 alarms in memory while the text file contains the full record of alarms for a particular project.

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5.5 Network Configuration: Alarms Property Page

Use this dialog to configure alarm email notification options. Alarm trigger thresholds are also configured on the Network Configuration/Stats property page, and the "Network Configuration/Network" page under "Advanced/Error Recovery Options".

Applicable Network Types: Real-time

To Access: Select "Network/Configuration" main menu item, or the button on the toolbar; then select the "Alarms" tab on the "Network Configuration" window.

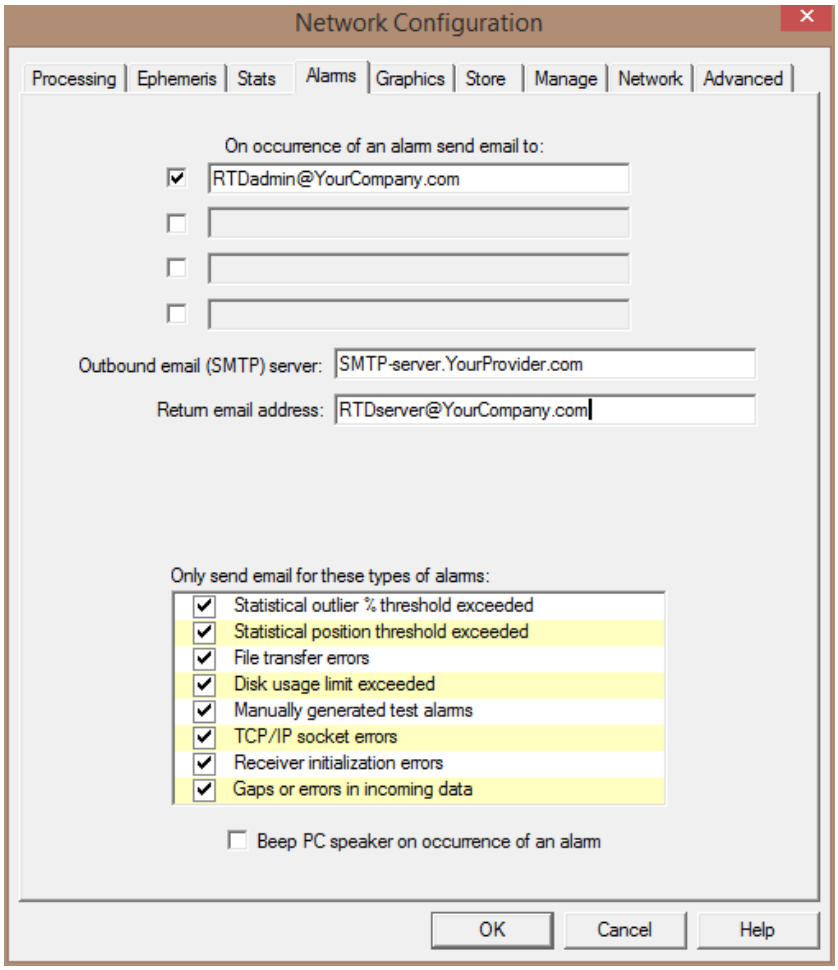

Figure 27 – Network Configuration: Alarms

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Field descriptions:

On occurrence of an alarm send email to
In addition to logging alarms to a text file, GeoRTD can be configured to send an e-mail message every time an alarm occurs. Up to four email addresses may be entered. To send alarms to an addressee, check the corresponding box.

Email configuration fields
In order to mail alarms, the computer workstation must be able to connect to an outbound SMTP server through a local area network, a broadband connection, or a modem dial-up connection.

Outbound email (SMTP) server:
Enter the address of your email SMTP server. This is where GeoRTD will send the alarm email messages.

Return email address:
Enter the return address that GeoRTD should include with the alarm email messages.

To test that GeoRTD can successfully email alarms, open a GeoRTD configuration, add an email address to the alarms settings, specify an SMTP server; then select the main menu item "Tools/Generate Alarm". This feature exists specifically for testing GeoRTD's alarm capability. This causes GeoRTD to generate a test alarm, which should be processed and recorded, as are actual alarms, including email notification.

Only send email for these types of alarms
Use this option screen to choose the alarms types for which email should be sent. These include:

Alarm Type	Explanation
Statistical outlier % threshold exceeded	1.) The statistical median calculated was outside of the user specified tolerance, or 2.) The outlier count was exceeded during calculation of periodic or daily statistics, i.e., the data are of too poor quality to calculate meaningful statistics. Defined on Statistical Processing window of the Network Configuration/Stats dialog.
Statistical position threshold exceeded	Defined on “Generate an alarm if…” window of the Network Configuration/Stats dialog.
File transfer errors	Failure in transferring files per a transfer procedure specified by the user on the Network Configuration//Manage dialog.
RAS connection failures	A dial-up internet account has been selected for use in emailing alarms and a connection to it could not be established.

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Alarm Type	Explanation
Disk usage limit exceeded	A hard drive where data are being stored has filled past a user specified threshold. Defined on top of Network Configuration/Store dialog.
Manually generated test alarms	For testing alarm features
TCP/IP socket errors	A site in a real-time network that is using TCP/IP to communicate experienced an error and was disconnected.
Receiver initialization errors	Upon connection to a site in a real-time network, the connection was valid but the receiver could not be initialized; it was not responding to commands.
Gaps or errors in incoming data	1.) No data from a site in a real-time network were received for a user specified number of minutes, or 2.) Data were received, but no solutions (positions) were determined for a site in a real-time network for a user specified number of minutes (indicating receiver problems or delays in the communications link). These alarm thresholds are set in the Error Handling Options window of the Advanced Network Options dialog. This dialog is available from the bottom of the Network Configuration/Network dialog.
SP3 download errors	1.) An error occurred when attempting to download SP3 ephemeris files, or 2.) An error occurred when reading an SP3 file, or 3.) The downloaded SP3 files do not contain sufficient coverage for the desired post-processing timespan.
Receiver download errors	1.) The data did not exist on the receiver. 2.) The difference between PC time and receiver time exceeded 1 hour. 3.) The user aborted during the download.

Table 8 – Network Configuration: Alarms

Beep PC speaker on occurrence of alarm

Use this option to enable an audible alert from your internal PC speaker when an alarm is issued.

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5.6 Network Configuration: Graphics Property Page

Use this dialog to configure graphics parameters.

Applicable Network Types: Real-time, Post-process

To Access: Select “Network / Configuration” main menu item, or the button on the toolbar; then select the “Graphics” tab on the network configuration window.

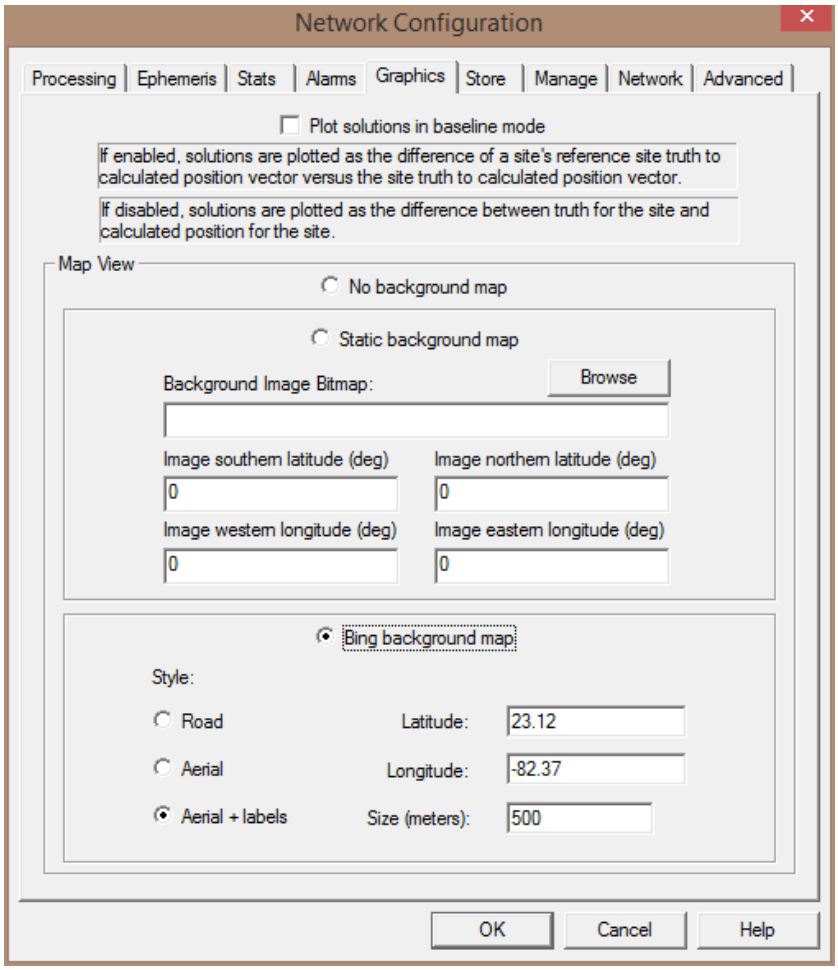

Figure 28 – Network Configuration: Graphics

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Field descriptions:

Plot solutions in baseline mode

If enabled, solutions are plotted as the difference of the *a priori* baseline and estimated baseline coordinates. The baseline is defined as the coordinate differences between a site and its reference site. If disabled, solutions are plotted as the difference between the *a priori* and estimated site coordinates, for each site.

Note: Baseline mode is particularly useful for plotting the relative positions of several dynamic platforms (sites).

Map View

Use this field to specify the filename of a bitmap image to be displayed as a background map in the Map View of the graphics window.

To determine the correct scale of the map the user must specify the upper and lower latitude and longitude values (in degrees) of the background map.

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5.7 Network Configuration: Store Property Page

Use this dialog to control which types of data to store and where data are to be stored.

Applicable Network Types: Real-time, Post-process

To Access: Select “Network / Configuration” main menu item, or the button on the toolbar, then select the “Store” tab on the network configuration window.

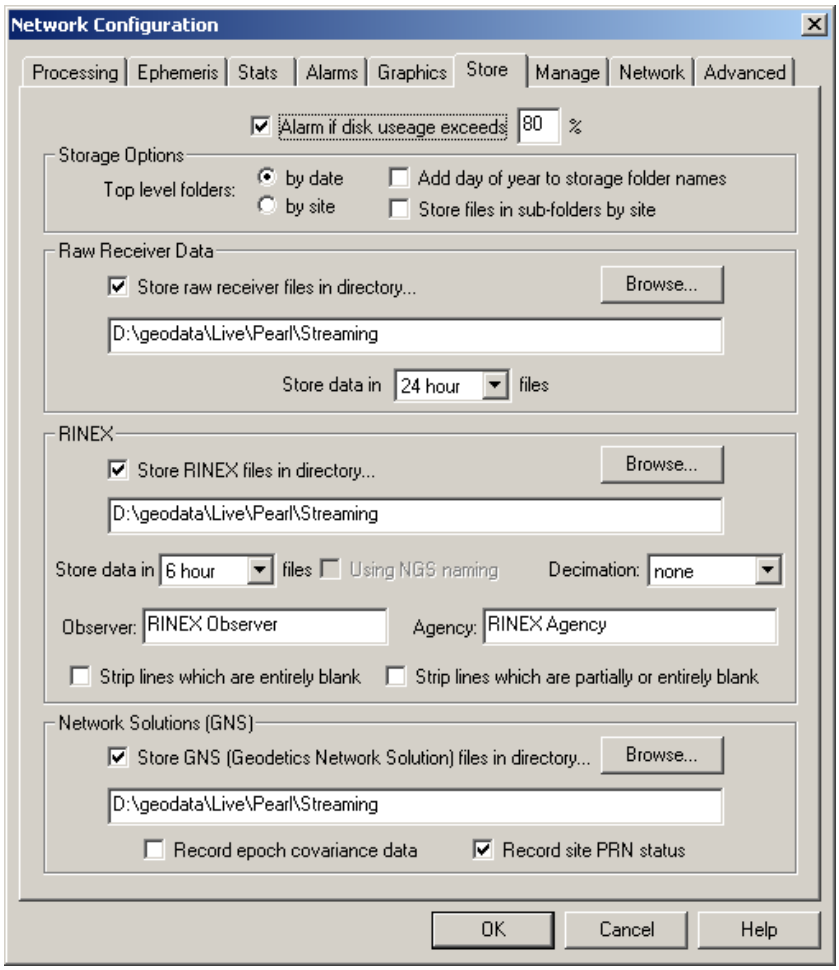

Figure 29 – Network Configuration: Store

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Field descriptions:

Alarm if disk usage exceeds …
If enabled, hard drives on the PC will be checked periodically and an alarm generated if the specified threshold is exceeded.

Storage Options
All recorded files are stored in a directory hierarchy. They can be sorted by date or site at a top level, then optionally further sorted into subfolders by date or site. There is also an option to append the day of year to the end of date folder names.

Raw Receiver Data (ignored in post-processing mode)
Use this field to store the raw data streamed or downloaded from the sites into files for later use or examination. Enable this feature by checking the box next to “Store raw receiver files...” and specify a path to the desired target directory. The Browse button will provide a window that can be used to find and specify this path.

GeoRTD will create a folder named “BINARY” in the directory specified. Subdirectories will be created under this folder as specified by settings in “Storage Options”.

GeoRTD can store the raw receiver data in files spanning 15 minutes to 24 hours (the default is 24 hours). The user can specify this interval using the list box below the directory path.

RINEX
Use this field to generate RINEX formatted files from the raw data downloaded from the network and store them for later use or examination. Enable this feature by checking the box next to “Store RINEX files...” and specify a path to the desired target directory. The Browse button will provide a window that can be used to find and specify this path.

GeoRTD will create a folder named “RINEX” in the directory specified. Subdirectories will be created under this folder as specified by settings in “Storage Options”.

GeoRTD can store RINEX data in files spanning 15 minutes to 24 hours (the default is 24 hours). The user can specify this interval using the “Store data in” list box below the directory path. Additionally, GeoRTD can be directed to use the NGS naming convention for RINEX files. This option is only available for 1-hour data files.

Decimation
In order to reduce the size of data files, GeoRTD can automatically create RINEX files that are decimated by specifying a decimation interval. The default is none, which means no decimation will be performed.

Specifying any other interval indicates how often an observation will be written out to the RINEX files. For example, a decimation interval of 1 minute means that only the observations that fall on minute boundaries will be written into the RINEX files. Observations falling between the interval boundaries will not be written into the RINEX files.

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Observer and Agency fields
The text entered here will be inserted into the header of all of the RINEX files generated by GeoRTD.

Line stripping options
Check the appropriate box to have GeoRTD strip out lines that are entirely or partially blank. If observables are missing for an epoch, by default they will be output to RINEX as blank fields.

RINEX file naming convention:
If 1-hour data files are being generated and NGS file naming is enabled, the names of the RINEX files generated and stored by GeoRTD will have the following format:

ssssDOYX.YYO where X ranges from a-x depending on the hour.

If NGS naming is not used, the names of the RINEX files generated and stored by GeoRTD will have the following format:

ssssdoy_HSMS_HLML.YYO
where ssss is the 4-character site code
DOY is the day of year
HSMS is the hours, minutes of start (GPS) time for the data
HLML is the hours, minutes of time interval contained in the file
YY is the last two digits of year

For example, hgkg323_0600_0600.00O. This file starts at 06:00 (GPS time) and contains 6 hours of RINEX data from day 323, year 2000. Exception: A 24-hour RINEX file will have the format ssssdoy0.yyO

Note: In addition to ephemeris files for each site, GeoRTD also creates an aggregate ephemeris file beginning with the pseudo-site ID “EPH” that includes a single complete set of all ephemeris data collected by the network.

Network Solutions (GNS)
Use this field to generate and store Geodetics Network Solutions (GNS) files. Geodetics solutions are the results for Epoch-by-Epoch™ solutions of the network. GeoRTD has the ability to read these files and manipulate and/or plot the solutions (see the **Quick Start: Viewing GNS Files** and **Tools/Convert GNS to Text** commands).

Enable this feature by checking the box next to “Store Geodetics solutions...” and specify a path to the desired target directory. The Browse button will provide a window that can be used to find and specify this path.

When this option is enabled, GeoRTD will create a folder named “NetworkSolutions” in the directory specified and record GNS files there. GNS files are 24 hours in length in segments of GPS days. In addition two GNS files are created which will contain all periodic medians and all daily medians, respectively.

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Naming conventions:
Each solutions file will start with the name of the current project, and follow this format:

[GeoRTD_project]_YYYT_MM_DD.gns	Solutions for each epoch in a GPS day
[GeoRTD_project]_periodic_medians.gns	Medians of solutions for each period
[GeoRTD_project]_daily_medians.gns	Median of periodic medians for each 24-hour period

where < GeoRTD project > is the name of the current configuration file, “YYYY” is the year, “MM” is the month, and “DD” is the day.

Record covariance epoch data:
Enable this option to record covariance information in the GNS files. Note: checking this option will increase significantly the size of the GNS file.

Record site PRN status
Enable this option to record PRN status, (tracking, azimuth, and elevation) in the GNS files.

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5.8 Network Configuration: Manage Property Page

Use this dialog to configure data management tasks, file transfers and cleanup. File transfer procedures are file archival or replication tasks that are performed at set intervals. They are used to copy recorded data to other computers on a network or to FTP servers.

Applicable Network Types: Real-time

To Access: Select “Network / Configuration” main menu item, or the button on the toolbar; then select the “Manage” tab on the network configuration window.

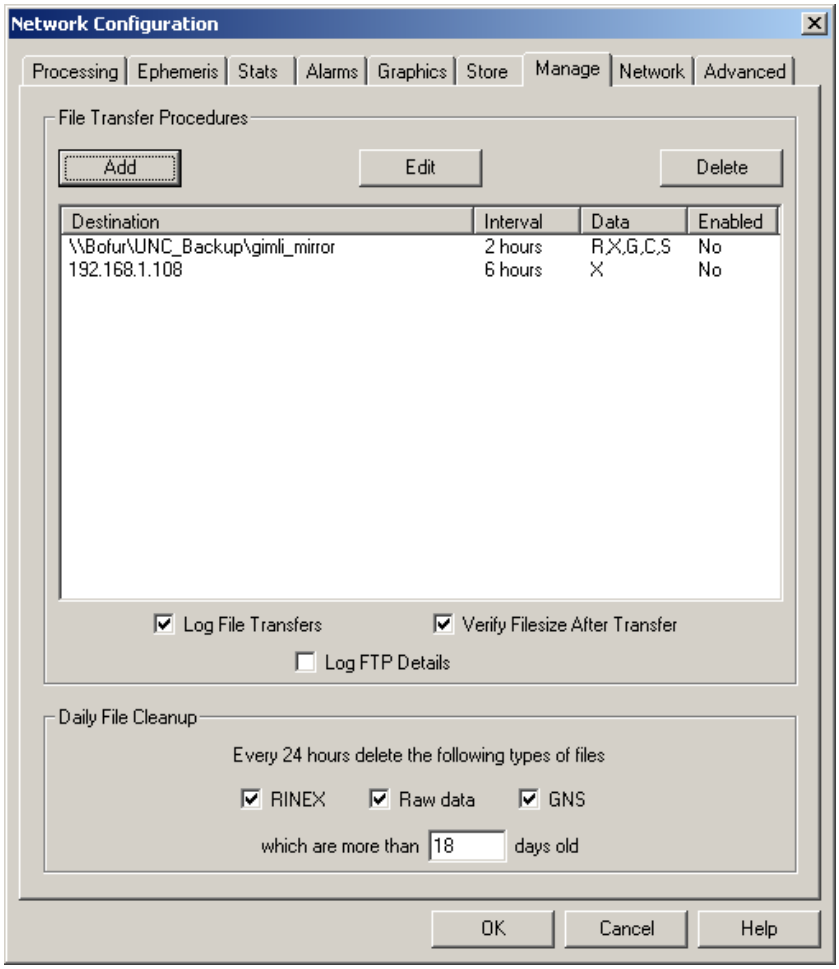

Figure 30 – Network Configuration: Manage

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Field descriptions:

File Transfer Procedures

GeoRTD provides the capability to periodically perform network or FTP copies of stored files. Use this window to define and manage file transfer procedures. Existing procedures are listed and summarized in the window, one per line. The summary for each procedure indicates its destination, how often the file transfer will be performed, and the types of data that will be transferred. Data types are abbreviated as follows:

X – Raw data files
R – RINEX files
G – GNS files (network solutions)
C – The network configuration file
S – The statistics database for the network

To Add a new procedure, press the Add button. To modify an existing procedure, select the procedure from the list and then press the Edit button. For either operation, a File Transfer Procedure dialog (see below) will appear so you can edit the procedure options.

To delete a procedure, select a procedure from the list and press the Delete button.

Log File Transfers

This option will create a log of all activity from all transfer procedures.

The log file will be begin with < GeoRTD project >_file_transfers, where < GeoRTD project > is replaced by the name of the current configuration file, and have a date appended. These files will be in a directory named “logs” under the directory containing the configuration file.

Verify Filesize After Transfer

This option will check the size of the file transferred versus the local copy after the transfer is complete, as an extra quality measure.

Log FTP Details

This option will create a detailed log of all FTP transactions. This is normally used when working with Geodetics technical support to identify possible ftp transfer problems.

Daily File Cleanup

Use this field to delete stored files that are older than a specified number of days. Use the checkboxes to indicate which types of files should be purged. Cleanup for each file type will be performed on any of the files under the corresponding directory specified on the “Network Configuration/Store” property page. If enabled, the cleanup is performed at the end of each GPS day, and after all file transfers have been completed.

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5.8.1 File Transfer Dialog:

This dialog allows entry or modification of the settings for an individual file transfer procedure.

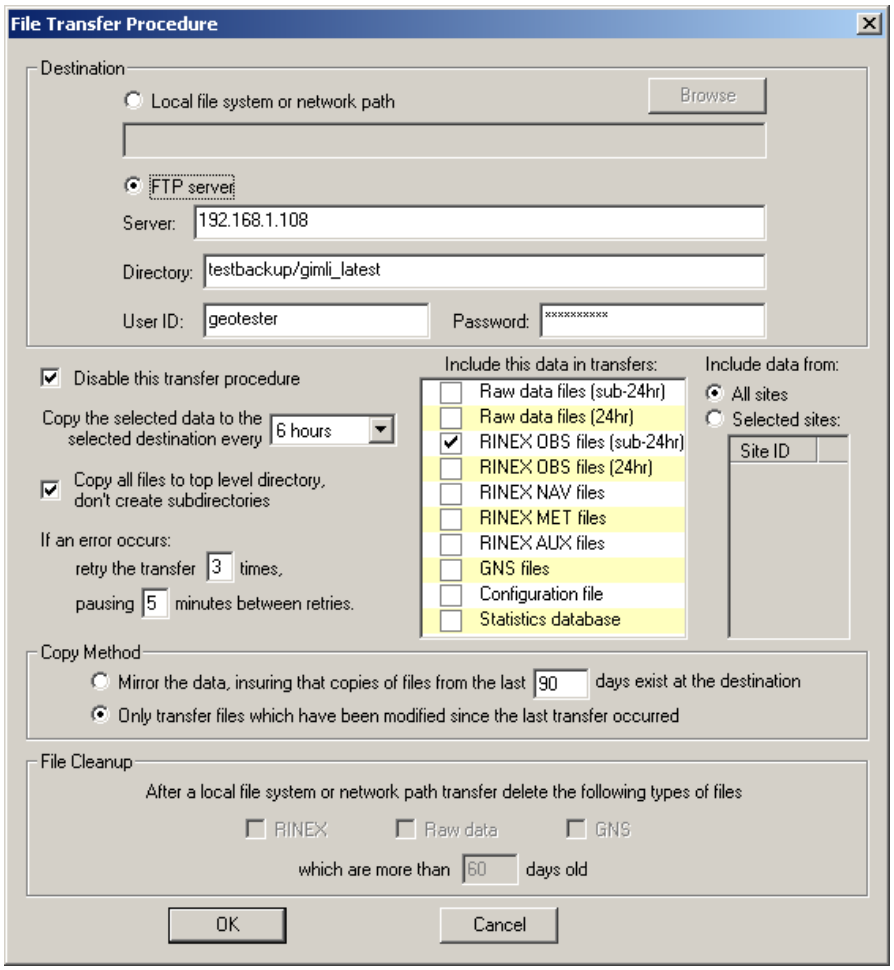

Figure 31 – File Transfer Dialog

<u>Destination</u>

Use this section to specify information about the destination for the file transfer procedure. The first decision is whether the procedure will store the files to a local or network path or FTP files to a server at a remote site.

<u>Local file system or network path</u>

When enabling this option, the user must specify the local directory or network path. The Browse button will provide a window that can be used to find and specify this path.

<u>FTP server</u>

The remote site must be specified in the **Server** field, and GeoRTD will transfer files to the directory on the remote server that is specified in the **Directory** field. A valid **User ID** and **Password** must be provided for access to the server/directory combination.

<u>Disable this transfer procedure</u>

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If this box is checked, no files will be transferred by this procedure. Use this to deactivate a procedure without deleting settings you may want to use at a later time.

Copy the selected data...every...
Specify the interval at which this procedure should be executed. Intervals from 15 minutes to 24 hours may be selected.

Copy all files to top level...
Normally file structure at the destination will mirror the original file structure (with folders for each data type and subfolders for each day). Check this box, if you would rather have all the files in a single top-level directory.

If an error occurs...
Use these fields to specify what the procedure should do if the first transfer attempt fails.

Include this data in transfers
Check the box of each type of file that you want transferred by this procedure, and for which sites in the network.

Copy Method
Use this area to select between the two copy methods for the procedure:

Mirror the data...
If this option is selected, every time the transfer procedure is executed it will make sure that up-to-date copies of all specified files exist at the destination. If destination files have been deleted or renamed, they will be retransferred. User can specify how many days back the data will be mirrored.

Only Transfer files that have been modified...
If this option is selected the procedure will only transfer files that have changed since the last transfer occurred.

File Cleanup
For network transfer procedures, use this option to remove old files at the destination. This will be performed after the rest of the transfer procedure is completed.

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5.9 Network Configuration: Network Property Page

Use this dialog to configure GeoRTD server/client interactions (described below).

Applicable Network Types: Real-time

To Access: Select “Network / Configuration” main menu item, or the button on the toolbar; then select the “Network” tab on the network configuration window.

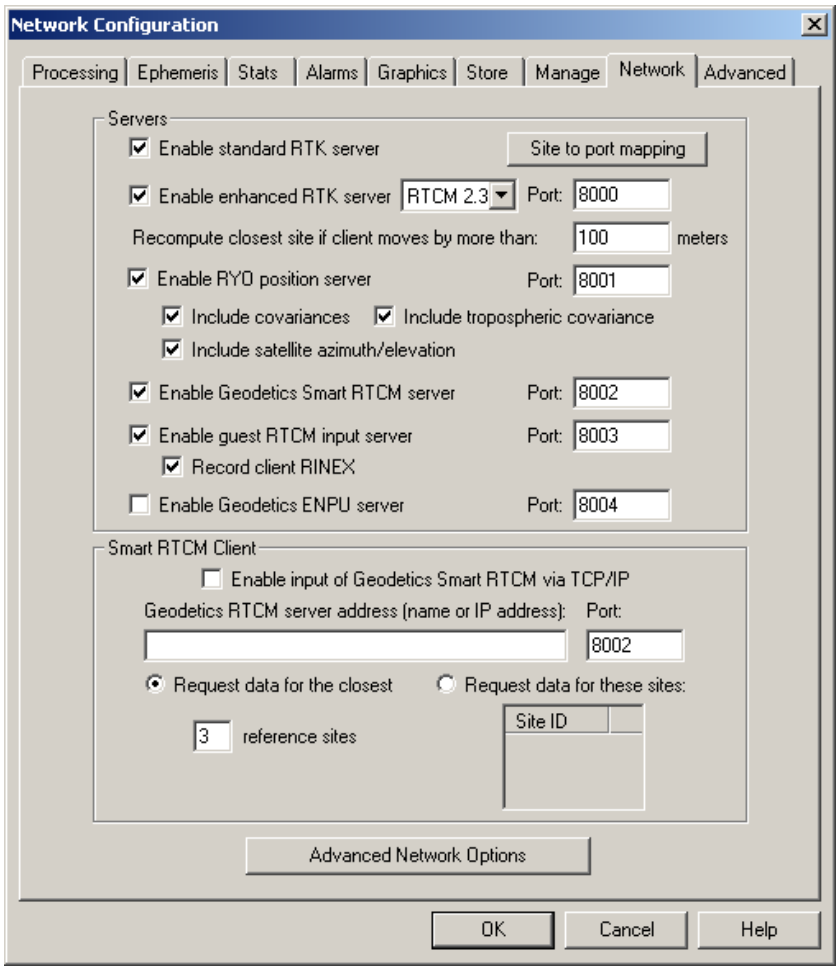

Figure 32 – Network Configuration: Network

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Field descriptions:

Servers

These options configure the various server options within GeoRTD.

The “Standard” and “Enhanced” RTK options were designed to enable clients to utilize their existing RTK rover equipment with GeoRTD. In essence, the functionality of the RTK base station is replaced with the GeoRTD reference network. A client makes a TCP/IP connection to the server and receives RTCM 2.2, RTCM 2.3, CMR or CMR+ data from GeoRTD, which is utilized by the client’s rover RTK system for precise positioning.

Enable Standard RTK Server
The GeoRTD administrator assigns a unique TCP/IP port and output RTK format for each site in the reference network to be accessible by clients. The client must have knowledge of the IP number and port/format assignments, and specify a single port for transfer of data of a particular format. The GeoRTD administrator assigns ports to GeoRTD network sites using the **Edit Site-Port Mapping** button, which displays the following dialog:

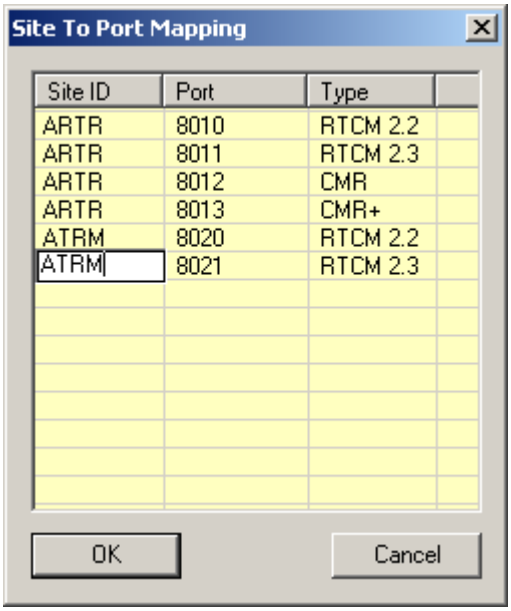

Figure 33 – Site to Port Mapping

Network sites are identified in the dialog by their four-character GeoRTD network code. To make a new mapping entry, simply type in the site code and port, then select what type of RTK data should be output on that port. A mapping entry can be likewise modified by direct entry into its fields. To remove a mapping, simply clear the fields by selecting them and then using the delete key. To accept the changes made on the port mapping page, select OK. Selecting Cancel will discard any changes you have made.

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Once a mapping is made, the GeoRTD server will accept connections from clients on the specified TCP/IP port and deliver RTCM, CMR, or CMR+ data to the client from the site. It is the responsibility of the GeoRTD administrator to inform clients of the reference site to port/format mappings so that they can connect up to the appropriate port.

To enable the "Standard" RTK Server, simply check the "Enable Standard RTK Client Connections" check box and use the "Edit Site-Port Mapping" dialog to set up the site mapping.

Enable Enhanced RTK Server

With the standard RTK server, the GeoRTD administrator assigns a single TCP/IP port for reference network to be accessible by clients. The client must have knowledge of the IP number and port/format assignment, and the administrator must specify a single port for transfer of data of a particular format.

With the "Enhanced RTK" server option, upon connection to the specified TCP/IP port by a client, GeoRTD will automatically select the network reference site closest to the client's position, and stream RTCM data to the client from that site. In order to do this, the client must be configured to transmit the NMEA GGA string with its position. In this mode, the client need only have knowledge of a single port and IP number.

To enable the "Enhanced RTK" Server, check the "Enable Enhanced RTK Client Connections" check box, select the version of RTCM (2.2.or 2.3) to be output, and enter the port number upon which you would like the server to accept client connections. This is the responsibility of the GeoRTD administrator.

Re-compute closest site if client moves by more than…

The "Enhanced" RTK server uses this setting to determine how much client movement (in meters) is needed before it re-computes the closest network site. A low value will cause the Enhanced RTK server to re-compute the closest site more frequently.

Enable Position Server

Use this option to enable the position server feature of GeoRTD. This feature makes GeoRTD computed Epoch-by-Epoch™ site positions available as a real-time data stream to external programs/applications. The server will accept connections from clients on the specified TCP/IP port and deliver the GeoRTD computed positions of each site in the network to the client, in the Geodetics RYO position message protocol. For details on the RYO protocol, see Appendix C: Protocols and Formats. To enable the Position server, check the "Enable output to position client" check box and enter the port number for client connections. Also select any RYO optional information to be transmitted, including covariance values (optionally including tropospheric covariance) and satellite information.

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Enable Smart RTCM Server

The "Smart" RTCM Server is used to provide RTCM data simultaneously from multiple reference sites to a client for superior position determination. The client must be a PC or PDA application that has Geodetics Smart Client software (i.e., GeoRTD Rover). Using this, a Geodetics Smart Client (described below) can connect to a local receiver and a GeoRTD Smart RTCM Server and apply Epoch-by-Epoch™ processing with input from several reference sites for position analysis of the field receiver. GeoRTD with Smart RTCM Server enabled would normally be enabled for an GeoRTD installation controlling a reference network, and Smart Clients would be run for applications such as surveying with respect to the reference network.

Depending on whether or not the client has a locally connected receiver in its own network, the number of GeoRTD network sites the server delivers to the client will vary. If the client does not have a locally connected receiver, the server will deliver observation data from all its network sites. In this configuration, the client in essence mirrors the server. If the client has at least one locally connected receiver, the client can choose the number of sites it would like to receive observations for. Thus the client can control the amount of data being transmitted and can compensate for varying bandwidth. In either case, for each server network site that the server will be transmitting observation data for, the server will first transmit all data relevant to the site such that the client can automatically add the site to its own network (i.e. site name, position etc.).

The client will receive this information and automatically add the sites to its own network. The client then receives observation data and computes individual baselines between the receivers in its network. The computation of these baselines is made on an Epoch-by-Epoch™ basis, thus no initialization and re-initialization is required. Because the client computes baselines from multiple directions instantaneously, the client is able to quickly verify, with a high degree of certainty, the computed client position.

To enable the Smart RTCM Server, simply check the "Enable output to Smart Client" check box and enter the port upon which you would like the server to accept client connections.

Enable Guest RTCM Input Server

Use this option to enable the guest RTCM input server feature of GeoRTD. A client connecting to this server is expected to transmit RTCM to GeoRTD. GeoRTD will then use reference site information to determine the position of the guest client, and transmit a NMEA GGA position message back to the client at each epoch. Each guest client that connects is inserted as a new site in the GeoRTD network automatically, and is automatically removed when the client disconnects.

Solutions for each guest client are automatically stored in the logs/RTCMGuests folder. The file naming scheme is as follows:

yyyy_mm,aaa_bbb_ccc_ddd.txt, where:

yyyy and mm are the year and month, respectively

aaa – ddd contain the four digit IP address of the guest client or clients.

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Record client RINEX

Use this option if you want GeoRTD to record the observations from guest clients in RINEX format. These RINEX files are then stored in the logs/RTCMGuests/RINEX folder and are sorted into folders by date. Each RINEX files spans 1 hour and is named as follows:

aaa_bbb_ccc_ddd_doy_ssss_0100.yyO, where:

aaa – ddd contain the four digit IP address of the guest client or clients.
doy is the 3-digit day of year.
ssss is the hour of day at the start of the file, 0000 through 2300
yy is the two-digit year.

RTCM Smart Client

The RTCM Smart Client works in tandem with the "Smart" RTCM Server described above. It performs similar functions as the Geodetics GeoRTD Rover product. The client's network can consist of any locally connected receivers, and any number of network sites from an GeoRTD server. The client receives observation data from its locally connected receivers and the observation stream from the server network reference sites, and computes Epoch-by-Epoch™ network solutions.

To enable the RTCM Smart Client, check the "Enable Input of RTCM via TCP/IP" check box, enter the number of sites you would like the server to deliver data for in the "Request data from the closest" field (this field only has an effect if the client has a locally connected receiver – otherwise all server network sites are streamed to the client). Alternatively, specific reference sites can be requested. Finally, enter the IP address (name or number) and port number of the Smart RTCM Server. The maximum number of sites that can be transmitted by the server is limited primarily by the bandwidth of the communication link and the receiver's sampling rate.

5.9.1 Advanced Network Options Dialog:

This dialog allows setting advanced and error recovery options associated with a GeoRTD Real-time network.

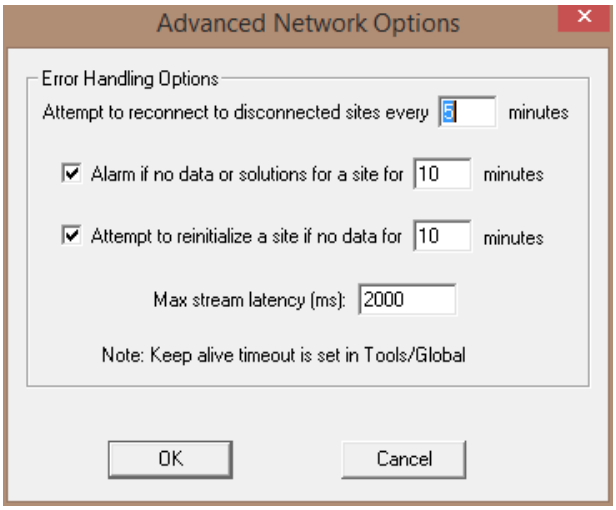

Figure 34 – Advanced Network Options Dialog

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Attempt to reconnect…
If a site in the network has disconnected, this option controls how often GeoRTD will attempt to reconnect to it. When a site on a TCP/IP connection gets disconnected, GeoRTD will attempt to reconnect immediately. If unsuccessful it will attempt to reconnect at this time interval.

Alarm if no data or solutions…
If a site in the network has sent no data, or is sending data but no position solutions can be calculated from it, GeoRTD can generate an alarm to notify of the problem, at this time interval.

Attempt to reinitialize
If a site in the network has sent no data over this time interval, use this option to have GeoRTD reinitialize the receiver to attempt to clear the problem.

Maximum Stream Latency (ms)
Observations from the network stations may arrive to GeoRTD at different times. GeoRTD waits for observations from **all** sites to arrive for an epoch before processing that epoch. However, if for some reason (such as communications problems), observations from a particular network site are being delayed, GeoRTD needs to know how long it should wait before excluding the latent site from processing. Use this field to specify how long GeoRTD should wait. Sites whose observations do not arrive to GeoRTD within this latency time will be excluded from processing, but will still be stored.

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5.10 Network Configuration: SINEX Property Page

Use this dialog to enable and configure the output of SINEX files.

Applicable Network Types: Post-process

To Access: Select “Network/Configuration” main menu item, or the button on the toolbar; then select the “SINEX” tab on the network configuration window.

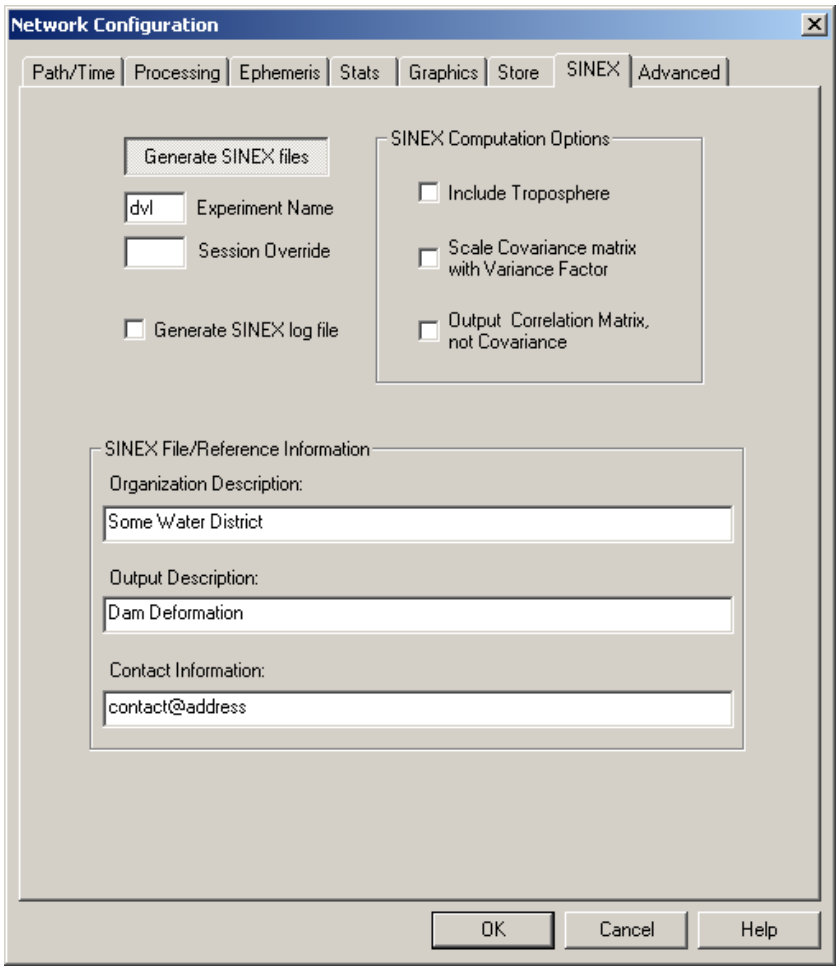

Figure 35 – Network Configuration: SINEX

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Field descriptions:

Generate SINEX Files

When this button is depressed, GeoRTD will generate a SINEX file at every statistics interval (as defined on the Network Configuration/Stats property page). SINEX files are generated with the following naming convention:

GEOxxxwwwwdss.SNX

where:
xxx is the experiment name (see below)
wwwwd is the GPS week/day of week of the SINEX data contained in the file
ss is the session number (see below)

Each statistics interval will generate a corresponding SINEX file. The session number corresponds to a particular interval and is used in the SINEX filename to differentiate the files for a given experiment.

By default the first statistics interval corresponds to session number 01, with subsequent intervals incrementing from there. If statistics are performed on the entire data set, the one SINEX file created will have a session number of “00”. The progression for session numbers beyond 99 is a0 to a9 and likewise b0 up to z9, where the counter will roll over to “00”.

The default starting point and counting progression can be changed by user input in the Session Override field (see below)

Experiment name

This is a three-character code to identify the data set being processed and is used as part of each SINEX filename.

Session Override

Use this two-character field to override the starting session number for the first statistics interval. Valid inputs are the digits 0-9 and characters a-z.

If a character (a-z) is entered in the second digit, then the session number progression is changed to cycle from 0-z instead of 0-9 before incrementing the first digit. For example: 01...0z, 10...1z, 20...zz.

If either digit is an uppercase character, then the SINEX filenames will be generated using all caps in the session field.

Generate SINEX Log File

Check this box to have GeoRTD generate a diagnostic log of the SINEX computation process. The file is named GEOxxxwwwwd.log and is located in the same directory as the network configuration file. WARNING: The SINEX log can be a very large file.

This option will also generate two files containing information about the outliers determined during the process of generating the SINEX file(s):

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GEOxxxwwwwd_Outlier.log	details about each outlier
GEOxxxwwwwd_OutlierSummary.log	a tabulation of valid observation and outlier count for each site

SINEX Computation Options:

Include Troposphere
Check this box if you want tropospheric parameters to be included in the SINEX file generation. NOTE: The source data files for the post-processing network must include tropospheric parameters for this option to be useful.

Scale Covariance matrix with Variance Factor
Check this box to have the covariance matrix that is generated in each SINEX file to be scaled by the Variance Factor ("chi-squared per degrees of freedom").

Output Correlation Matrix, not Covariance
Check this box to have each SINEX file contain the correlation matrix instead of the covariance matrix.

SINEX File/Reference Information:
The information in these fields will be placed in the FILE/REFERENCE block of each SINEX file:

Organization Description
Fill in the organization creating the SINEX files.

Output Description
Fill in text describing the contents of the SINEX files.

Contact Information
Address for the relevant contact person or office.

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5.11 Network Configuration: GNS File Property Page

Use this dialog to select the GNS file to be viewed and the starting and ending time (date/time or GPS week/second format) in the file to be viewed. This page applies to GeoRTD configurations for playback of GNS files.

Applicable Network Types: GNS File Playback

To Access: Select "Network Configuration" main menu item, or the button on the toolbar; then select the "GNS File" tab on the network configuration window.

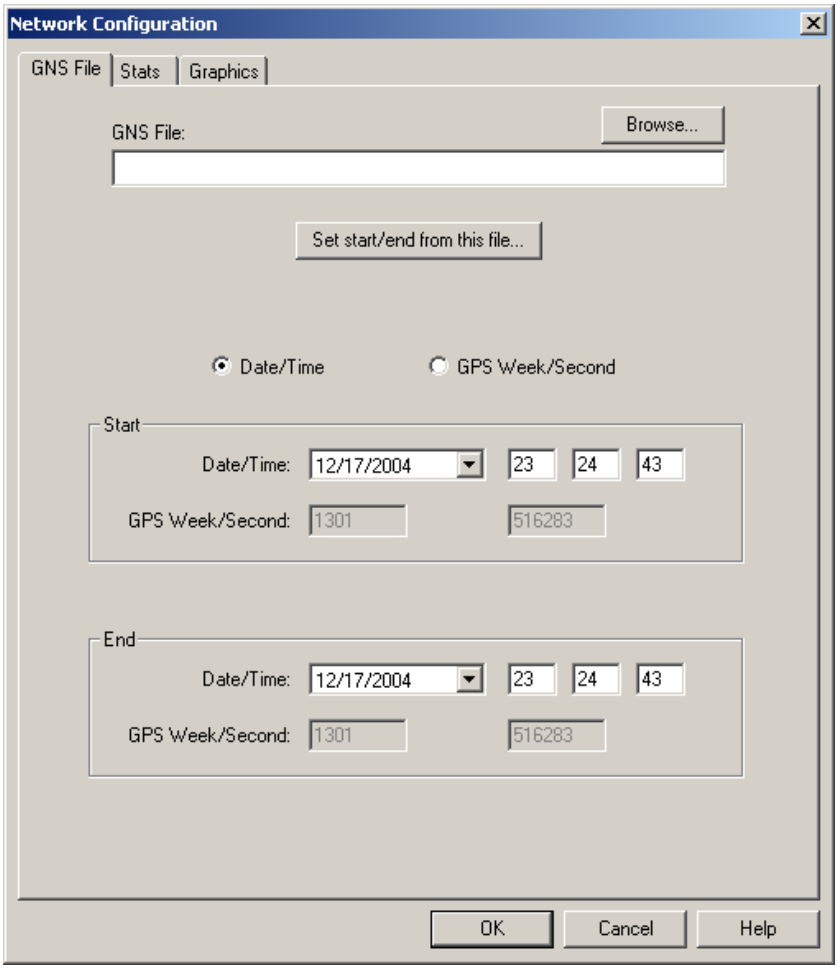

Figure 36 – Network Configuration: GNS File

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5.11.1 Network Configuration: Advanced Property Page

Use this dialog to configure various advanced GeoRTD options.

Applicable Network Types: Real-time, Post-process

To Access: Select “Network/Configuration” main menu item, or the button on the toolbar, then select the “Advanced” tab on the network configuration window.

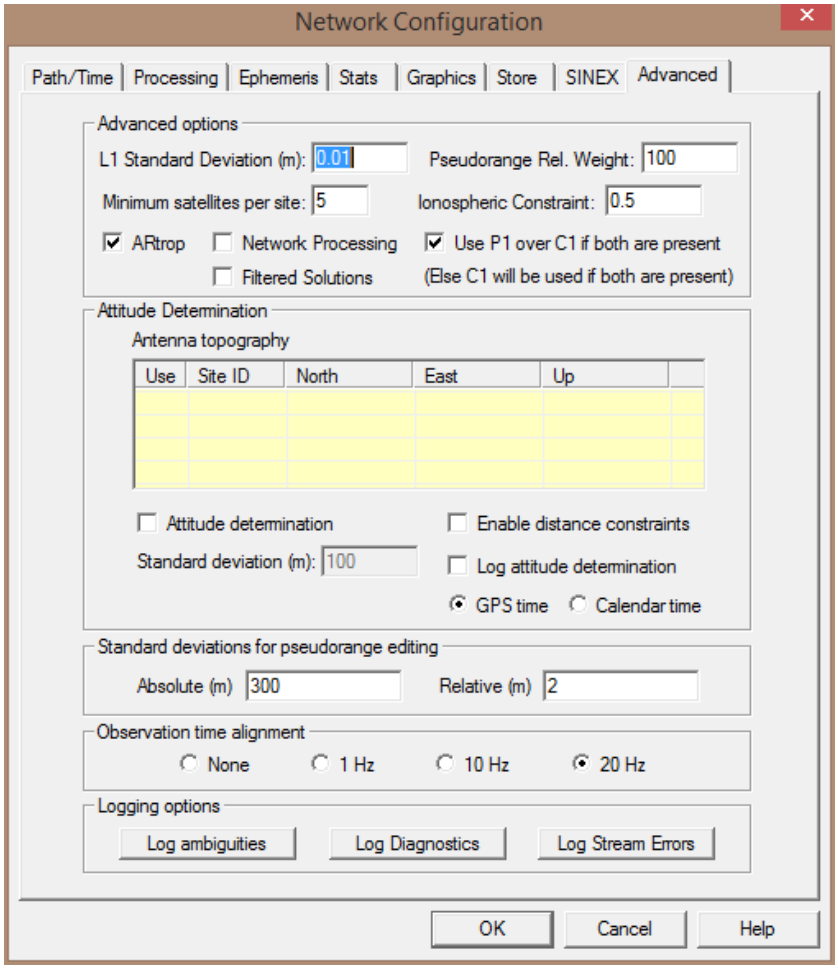

Figure 37 – Network Configuration: Advanced

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Field descriptions:

Advanced Options

Use this area to specify the following options and parameters:

Advanced Options	Description
L1 Standard Deviation (meters)	This is the error to be assigned to a phase measurement. We recommend a value of 0.01 m for this parameter.
Pseudorange Relative Weight (unitless)	The relative weight to be assigned to pseudorange observations as compared to the error assigned to the phase observations. We recommend a value of 100. Assuming a L1 standard deviation of 0.01 meters, a value of 100 assigns to the pseudorange a standard deviation of 1 meter.
Minimum satellites per site	Set the minimum number of satellites required for GeoRTD to attempt to compute a position. Although in some cases a solution can be obtained with 4 satellites, we recommend a minimum of 5.
ARTrop	If disabled, the ambiguity resolution stage is performed without estimating zenith delay parameters. If enabled zenith delay estimation is done simultaneously with ambiguity resolution. In either case, once the ambiguities are resolved, troposphere parameters are estimated in the final estimation stage. It is recommended that this option be enabled.
Network Processing	If disabled, the ambiguity resolution stage is performed in a wheel and spoke manner, with the Master station serving as hub and ambiguities resolved, baseline-by-baseline. This approach is extremely efficient and useful for large (many-station) networks. If enabled ambiguity resolution is performed as a network, a more rigorous approach statistically, but requiring more computations and more susceptible to outliers. This approach is currently limited to a network of no more than 16 stations. In either case, once the ambiguities are resolved, the final estimation stage is performed as a network. That is, GeoRTD performs an Epoch-by-Epoch™ network solution.
Filtered Solutions	[new function, what does it do?]
Use P1 over C1 if both are available	If receivers in the network generate both P1 and C1 code observations, use this option to select which to use. If the option is selected, P1 will be used. If not, C1 will be used.

Table 9 – Network Configuration: Advanced Options

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Attitude Determination

The options in this group box configure attitude determination. If attitude determination is enabled, the map view will be replaced with a navigation view (refer to the section describing the navigation view). To determine attitude, the layout of the antennas must be known. This information is to be entered in the “Antenna topography” grid. The leftmost column is a checkbox that should be checked if the antenna is on the mobile platform and is to be used to determine attitude. The rightmost columns are to contain the north, east, and up offsets of each antenna to an arbitrary reference point when the platform to which the antennas are attached is level and pointing due north. It is usually easiest to use the first antenna itself as a reference point, and give the offsets to the other antennas relative to the first.

Two or three antennas may be used for attitude determination. If two are used, only pitch and heading are calculated, it is assumed the antennas are mounted along the length of the body (e.g., aircraft). With three antennas roll may also be determined.

Attitude determination

Use this checkbox to enable or disable GeoRTD’s attitude determination mode.

Enable Distance constraints

Use this field to enable the application a distance constraint. This can to be used to improve results if the antennas are mounted on a rigid body with a known size and shape. The constraint is the approximate precision of the rigid-body distances, and is entered in the *Standard Deviation* field in units of meters.

Log Attitude determination

Enable this option to log attitude determination in addition to displaying it. Select GPS time or calendar time as the desired time format in this log.

Standard Deviations for Pseudorange Editing

Use this field to specify threshold criteria for rejecting observation data based on absolute and relative pseudorange solutions. Relative solutions are performed with respect to the Master Station (the first site in the network which is fixed for static configurations or when a reference receiver is present in the network). The default (and recommended) values are 300 m for absolute pseudorange editing, and 2 m for relative pseudorange editing.

Observation Time Alignment

GeoRTD analyzes data that are collected at a given time epoch. Use this option to have GeoRTD align observation times to the nearest second, 1/10 second, or 1/20 second, in order to specify the criteria for simultaneity. A non-zero assignment is necessary for networks with receivers (e.g., Trimble receivers) that do not perform clock steering and assign millisecond jumps to observation time tags. The assigned value should be set according to the highest sampling rate of a non-clock steering receiver in the network.

Logging Options

GeoRTD is able to generate several useful log files for diagnosing problems. Enable the desired log by depressing the appropriate button.

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The ambiguity log will contain the integer cycle phase ambiguity generated by GeoRTD at each epoch. The diagnostics log will contain messages detailing internal events within the program. This is useful in scenarios where technical support is required but it is impractical to send a support engineer to the location. Finally, the stream error log will contain any protocol errors encountered when communicating with the receivers. This can be used to monitor communication dropout and problems. A separate stream error log will be created for each site in the network if this option is enabled.

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6.0 GeoRTD Site Properties

The properties specific to an individual site in a network are set in the GeoRTD site properties window. To modify site properties, double-click the site in the site list to open the site property window. You can also right-click on the site in the site window and select “Properties” from the popup menu that appears. Each site has multiple pages, with each page controlling a different aspect of site properties, such as GPS equipment, site location and communication link. Each page is accessible through a tab on the site property window. Following is a list of site property pages:

Page	Description
General	Used to specify general site information such as the site code, name, antenna type, and whether site is enabled for data retrieval and processing.
Location	Allows entry and display of the location of the site in several coordinate systems, and specification of constraints to be applied to its *a priori* position, if any.
Filtering	Output filtering options (Post-processing networks only)
IMU	Enables the use of IMU data and allows entry of IMU type and configuration. (Post-processing networks only)

Table 10 – Common Site Property Pages:

Page	Description
Ashtech Stream	Used to specify the properties of an MBEN data stream being broadcast and monitored from an Ashtech receiver.
Leica LB2 Stream	Used to specify the properties of an LB2 data stream being broadcast and monitored from a Leica receiver.
Navcom NCT Stream	Used to specify the properties of an NCT data stream being broadcast and monitored from a Navcom receiver.
Novatel OEM4 Stream	Used to specify the properties of an OEM4 data stream being broadcast and monitored from a Novatel or Sokkia receiver.
SBP Stream	Used to specify the properties of a SiRF binary protocol (SBP) data stream being broadcast and monitored from a SiRF receiver.
Topcon GRIL Stream	Used to specify the properties of a GRIL data stream being broadcast and monitored from a Topcon receiver.
Trimble RT17 Stream	Used to specify the properties of an RT17 data stream being broadcast and monitored from a Trimble receiver.

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Page	Description
Initialization Control	Used to configure the separate communication path for initializing a Trimble NetRS receiver.
Port/Modem	Used to configure communications with a site using an RS-232 communication link to a receiver.
TCP/IP Socket	Used to configure communications with a site using a TCP/IP network communication link to a receiver.
Port/Modem	Used to configure communications with a site using an RS-232 communication link to a receiver.
TCP/IP Socket	Used to configure communications with a site using a TCP/IP network communication link to a receiver.

Table 11 – Possible Real-time Site Property Pages:

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6.1 Common Site Properties

6.1.1 Site Properties: General Property Page

Use this dialog to identify the site (code and name) and to control whether the site is used in data retrieval and processing. Additionally, receiver information, antenna type and eccentricity, and met sensor information can also be specified.

Applicable Network Types: Real-time, Post-process

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appear; then, select the “General” tab on the site properties window.

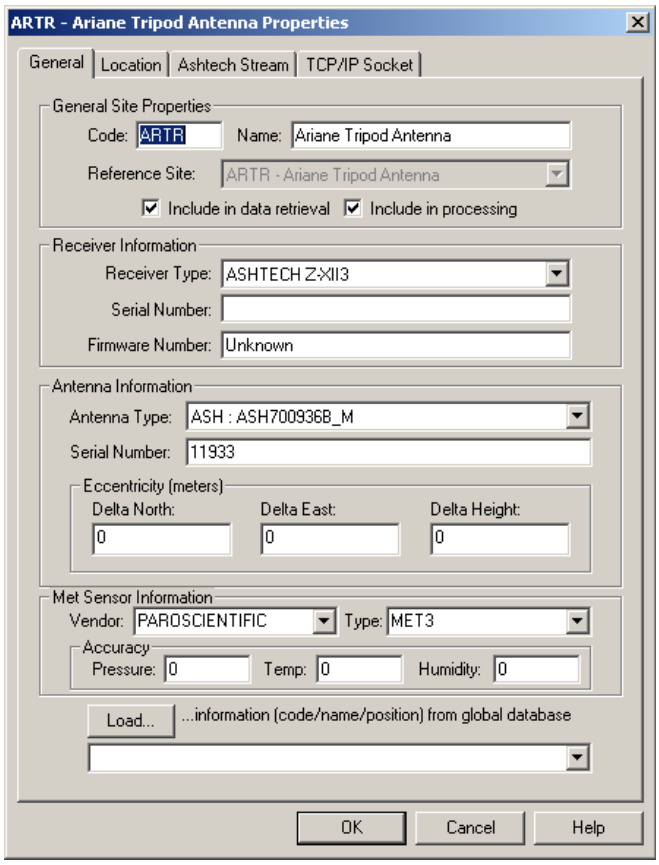

Figure 38 – General (Real-time)

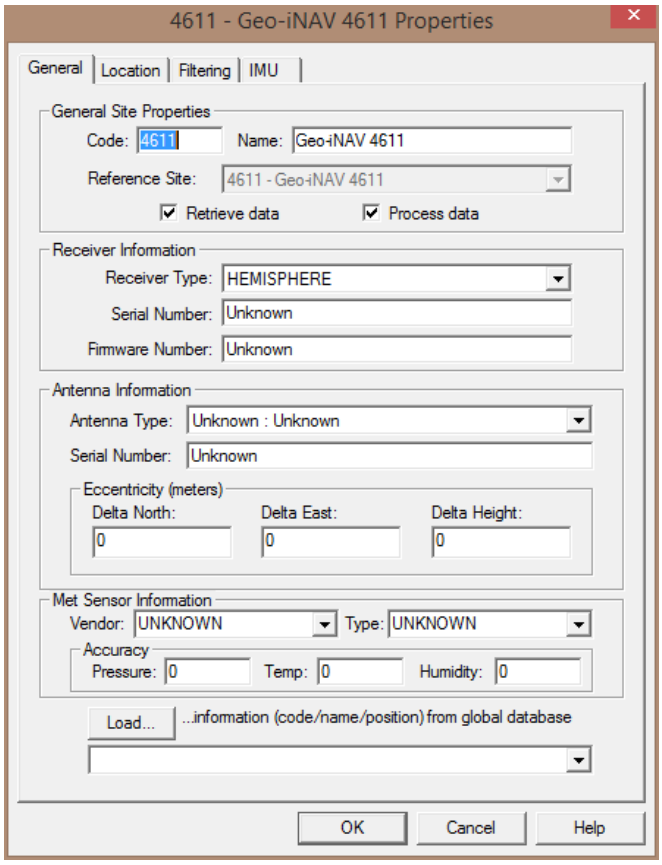

Figure 39 – General (Post-processing)

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Field descriptions:

General Site Properties

Site Code and Name
Specify a unique four-character code for the site, which will be used to identify the site. In addition a longer, more descriptive site name can also be specified.

A pre-defined site may also be selected from the GeoRTD global database using the interface window in the lower half of the dialog. The window lists all of the sites in the database. Clicking on the desired site and pressing the Load button will load the site code, site name and location data from the database.

Reference Site
Specify which site in the network should be used as the reference for this site. This is used for graphing solutions in baseline mode.

Data retrieval and processing checkboxes
Use these boxes to control whether data will be retrieved from this site, and whether the data will be included in the computation of the network solution. When a new site is added to the network, GeoRTD will default to including the site in data retrieval and processing (both boxes checked).

Receiver Information

Receiver Type
Select the appropriate receiver type for the site from the list.

Receiver Serial Number and Firmware Number
These values may be manually entered here, and will be used to populate the header of any RINEX observation files recorded for the site.

Antenna Information

Antenna Type
Select the appropriate antenna type for the site from the list. The antennas are listed by the manufacturer's model number. The default antenna type is "Unknown".

To import antenna types information into GeoRTD, use the "Tools/Import IGS Antenna Info" menu command.

Serial Number
Use this field to (optionally) enter the serial number of the antenna at the site. The antenna serial number is used to populate the RINEX observation file header.

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Eccentricity:
Specify the antenna eccentricity for the site in north, east and height components. The eccentricity is defined as offsets from a geodetic monument to the ARP (antenna reference point).

Met Sensor Information:

The information in these fields is used to populate the header for any RINEX met file that may be generated if a meteorological (met) sensor is installed at the site.

Vendor / Type
If a met sensor is installed at the site, select the appropriate vendor and type for the met sensor from these lists. The default for these fields is “Unknown”. If the vendor or type is not listed, you may type this information into the field(s) as necessary.

Accuracy: Pressure, Temp, Humidity
These fields are used to indicate the met sensor accuracy for each respective parameter.

Load Information … from global database

Commonly used site information can be stored in a global database for use in different GeoRTD configuration files. This is done under the main menu item “Tools/Global Data”. Site Ids, names, and coordinates can be entered in the global data, then loaded into the site properties by selecting the site in this list and hitting the “Load” button.

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6.1.2 Site Properties: Location Property Page

This dialog allows entry and display of *a priori* station coordinates, in different coordinate systems, and entry of coordinate and troposphere parameter constraints.

Applicable Network Types: Real-time, Post-process

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears; then, select the “Location” tab on the site properties window.

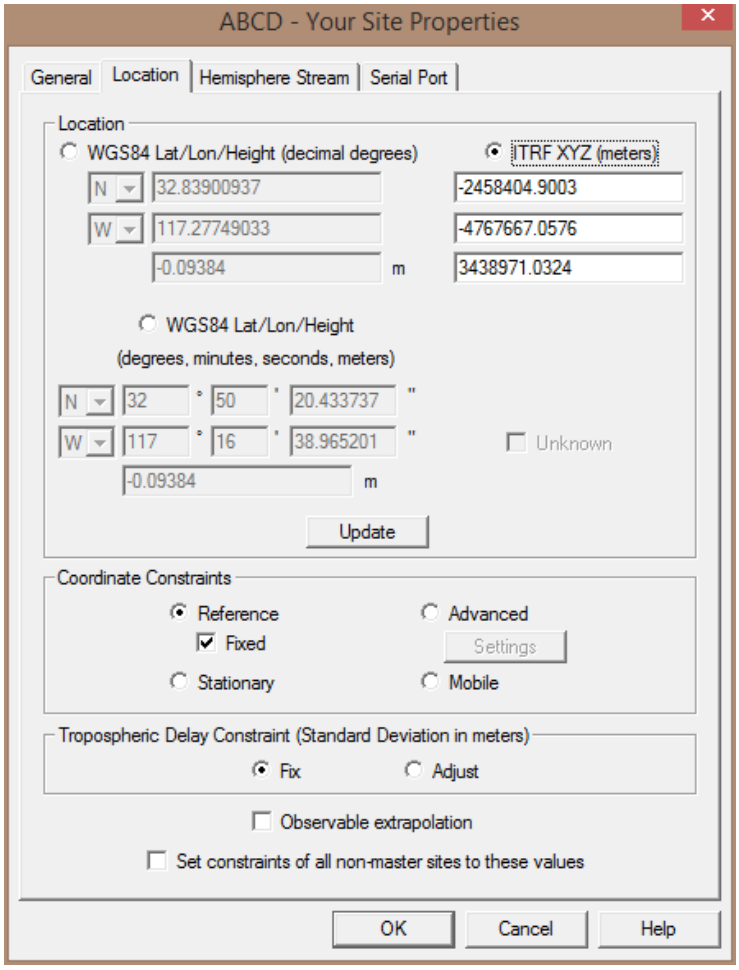

Figure 40 – Your Site Properties

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Field descriptions:

Location

This dialog supports entry of station coordinates in different coordinate systems. The coordinate systems include 1) Geocentric Cartesian (X,Y,Z), e.g., ITRF2000, in meters, 2) Geodetic Latitude, Longitude, and Height, e.g., WGS84 ellipsoid, in decimal degrees (latitude and longitude) and meters (height above ellipsoid), and 3) Geodetic Latitude, Longitude, and Height, e.g., WGS84 ellipsoid, in degrees, minutes, and seconds (latitude and longitude) and meters (height above ellipsoid). To select a coordinate system, select the radio button next to its description. Only the fields for the selected coordinate system will accept input. Pressing the **Update** button will transform the location in the active system into the other coordinate systems.

If "Unknown" is checked, location input is disabled, and GeoRTD will use the first calculated position for the site when the network is run.

It is recommended to always input the best possible a priori coordinates for a static site.

Coordinate Constraints

This dialog provides position constraint instructions for single-epoch estimation. "Reference" sites are stationary, have accurate *a priori* coordinates (cm-level), and are not expected to move. "Stationary" sites are static, may have less accurate a priori coordinates, and may be subject to motions less than 100 m. "Mobile" sites are antennas mounted on moving objects (e.g., a vehicle) whose *a priori* locations are generally unknown.

A reference site can also be fixed. That is, it's *a prior*i coordinates will not be allowed to adjust. There is no requirement for any site to be fixed, however, no more than one reference site should be designated as fixed. The fixed reference site is the Master site, and should be the first site entered into the GeoRTD configuration.

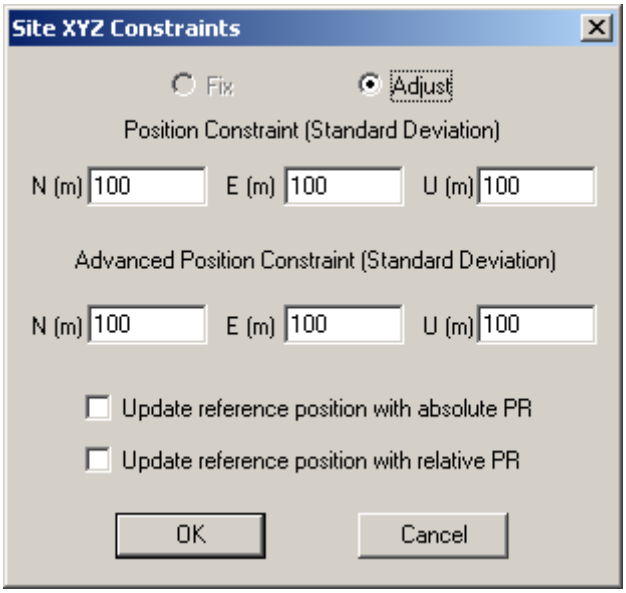

Figure 41 – Site XYZ Constraints

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The “Advanced” button allows for custom settings (see above). Site coordinates can either be specified fixed, or adjusted. Only the Master station should ever be fixed, but it need not be fixed, for example, when all network stations are mobile. Coordinate constraints can be set in either in a Cartesian (X, Y, Z) frame or Geodetic (N, E, U) frame (the frame can be set under “Tools/Global Data/Global Settings”). There are two levels of constraints in GeoRTD. “Advanced Position Constraints” are applied only at the ambiguity resolution stage of Epoch-by-Epoch™ processing. “Position Constraints” are used at the final stage, after ambiguities have been resolved. For most applications, there is no need to apply tighter constraints for the “Position Constraints” than the default values of 100 m. Single-epoch ambiguity resolution can often be improved by assigning realistic “Advanced Position Constraints,” but not tighter than 10 cm (the approximate wavelength of an ionosphere-free phase observable. For more information on constraints see section titled “The GeoRTD Framework-Concepts and Definitions”.

GeoRTD starts with user-specified *a priori* values for site coordinates. Adjustments are estimated for these parameters independently at each epoch by means of a linearized least-squares algorithm. The user can choose to update the *a priori* coordinate values based on an absolute pseudorange solution, or based on a relative pseudorange solution for a site with respect to the Master Site. Both of these should be chosen when positioning a mobile object, but should not be used, in general, for static sites.

Refer to section 2.5 Constraining estimated site positions for more details.

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Tropospheric Delay Constraints

Choose whether a troposphere zenith delay parameter is to be fixed or estimated for a site.

If a zenith delay parameter is adjusted, choose a zenith delay constraint. A zenith delay can be effectively fixed by applying a very tight constraint (e.g., 0.001 m). The default constraint of 0.5 m is a very loose constraint and has little influence on the estimated zenith delay. “Zenith delay constraints” are applied after ambiguity resolution in the final estimation of parameters.

Note: GeoRTD version 3.5 has the option to input an *a priori* zenith delay value, in addition to the zenith delay constraint. This feature will be expanded in future versions to enable input from external troposphere models.

“Advanced zenith delay constraints,” on the other hand, are used only at the ambiguity resolution stage. GeoRTD starts with an *a priori* model value for the zenith delay at a site.

Set Constraints of all non-master sites to these values

If the checkbox at the bottom of this window is checked, when the OK button is clicked the settings entered will be copied to all non-master sites in the network. This provides a convenient way to quickly update the same constraints for all sites.

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6.2 Real-Time Site Properties

6.2.1 Site Properties: Ashtech Stream Property Page

Use this dialog to specify the properties of the MBEN data stream from a site.

Applicable Network Types: Real-time

To Access: Double-click on the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears; then, select the “Ashtech Stream” tab on the site properties window.

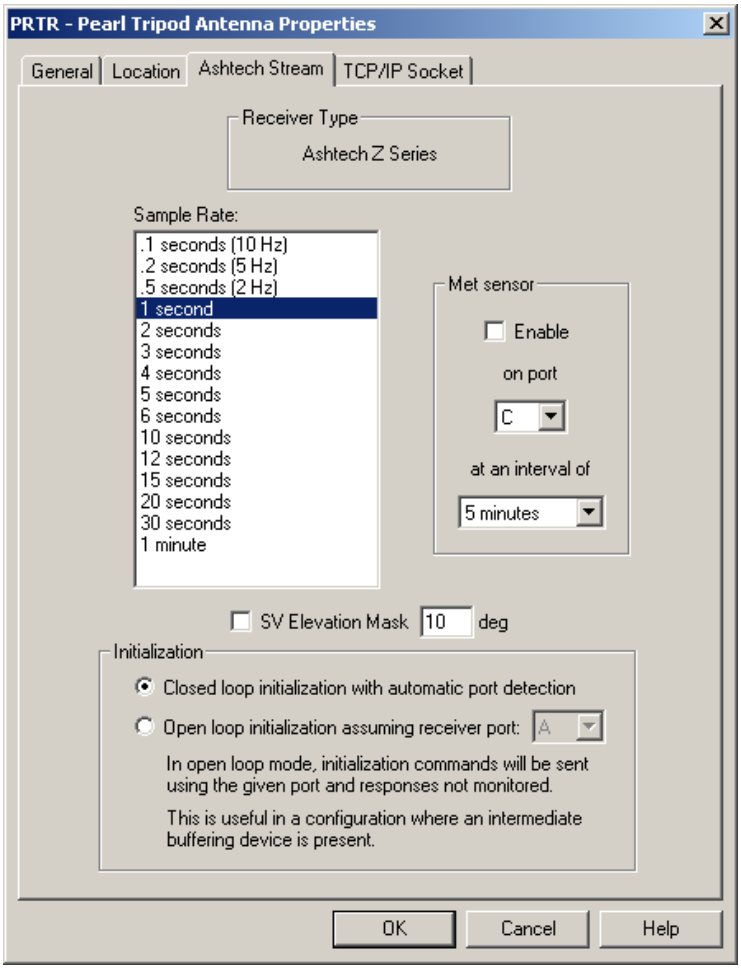

Figure 42 – Real-time Site Properties

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Field descriptions:

Receiver Type
This field displays the specific receiver type that was selected when the site was created.

Sample Rate
Select the rate at which data are to be sampled. GeoRTD will automatically configure the receiver to stream out data at the specified sample rate.

Met sensor
These options are used if a met sensor is present. Enable and set the port to which the met sensor is connected, and how often the met sensor is to be polled for data.

SV Elevation Mask
Enable this to have GeoRTD set the selectable elevation mask in the receiver, when initializing the receiver.

Initialization
Choose the initialization mode to be used. GeoRTD attempts to initialize the receiver each time it is connected to it. In closed loop initialization it will issue commands and listen for responses, generating an alarm if the responses are invalid or not present. In open loop initialization, the commands will be sent but responses not verified. Open loop initialization is necessary to accommodate intermediate devices in some cases, such as data buffers outside but connected to a receiver.

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6.2.2 Site Properties: Leica LB2 Stream Property Page

Use this dialog to specify the properties of the LB2 data stream from a site.

Applicable Network Types: Real-time

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears, then, select the “Leica LB2 Stream” tab on the site properties window.

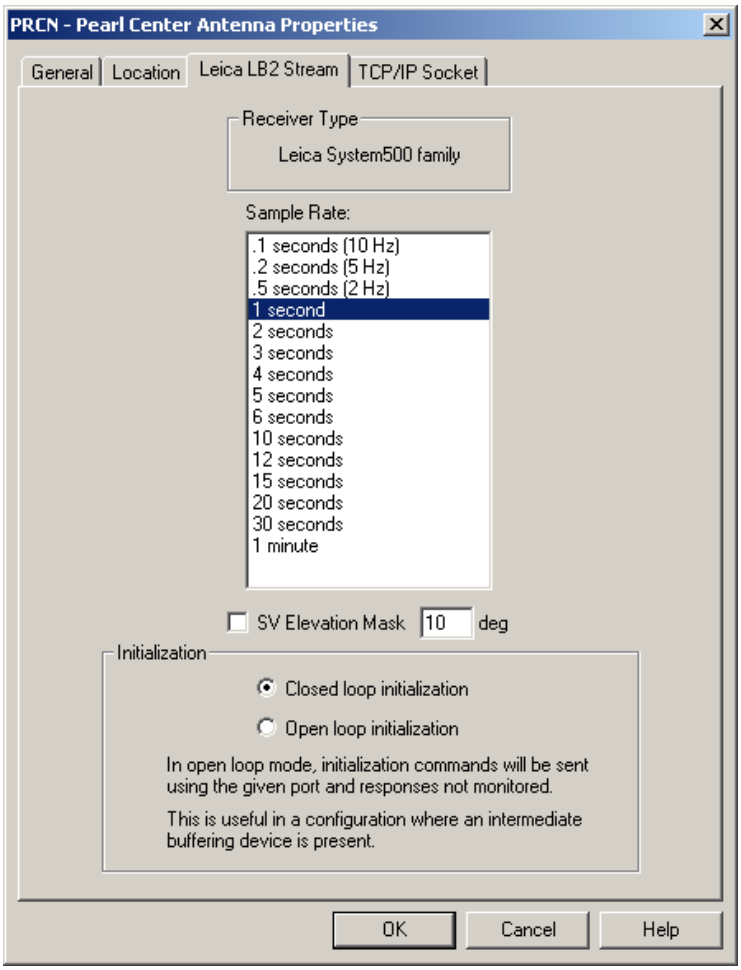

Figure 43 – Leica LB2 Stream Property Page

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Field descriptions:

Receiver Type
This field displays the specific receiver type that was selected when the site was created.

Sample Rate
Select the rate at which data are to be sampled. GeoRTD will automatically configure the receiver to stream out data at the specified sample rate.

SV Elevation Mask
Enable this to have GeoRTD set the selectable elevation mask in the receiver when initializing the receiver.

Initialization
Choose the initialization mode to be used. GeoRTD attempts to initialize the receiver each time it is connected to it. In closed loop initialization it will issue commands and listen for responses, generating an alarm if the responses are invalid or not present. In open loop initialization, the commands will be sent but responses not verified. Open loop initialization is necessary to accommodate intermediate devices in some cases, such as data buffers outside but connected to a receiver.

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6.2.3 Site Properties: Navcom NCT Stream Property Page

Use this dialog to specify the properties of the NCT data stream from a site.

Applicable Network Types: Real-time

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears, then, select the “Navcom NCT Stream” tab on the site properties window.

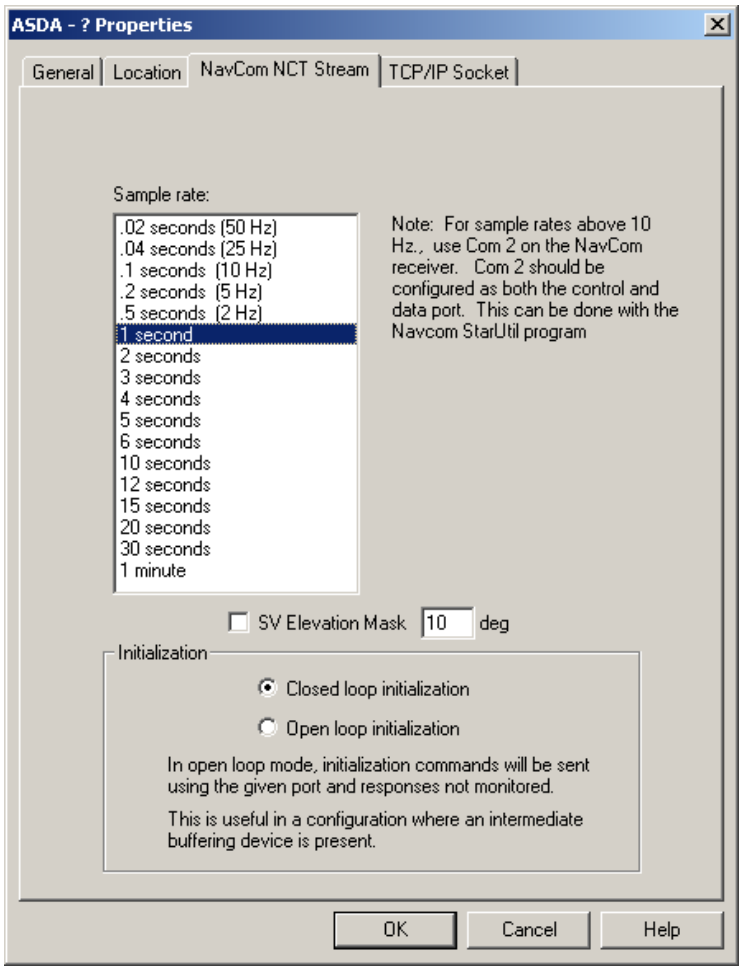

Figure 44 – Navcom NCT Stream Property Page

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Field descriptions:

Receiver Type
This field displays the specific receiver type that was selected when the site was created.

Sample Rate
Select the rate at which data are to be sampled. GeoRTD will automatically configure the receiver to stream out data at the specified sample rate.

SV Elevation Mask
Enable this to have GeoRTD set the selectable elevation mask in the receiver when initializing the receiver.

Initialization
Choose the initialization mode to be used. GeoRTD attempts to initialize the receiver each time it is connected to it. In closed loop initialization it will issue commands and listen for responses, generating an alarm if the responses are invalid or not present. In open loop initialization, the commands will be sent but responses not verified. Open loop initialization is necessary to accommodate intermediate devices in some cases, such as data buffers outside but connected to a receiver.

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6.2.4 Site Properties: Novatel OEM4 Stream Property Page

Use this dialog to specify the properties of the Novatel OEM4 data stream from a site.

Applicable Network Types: Real-time

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears, then, select the “Novatel OEM4 Stream” tab on the site properties window.

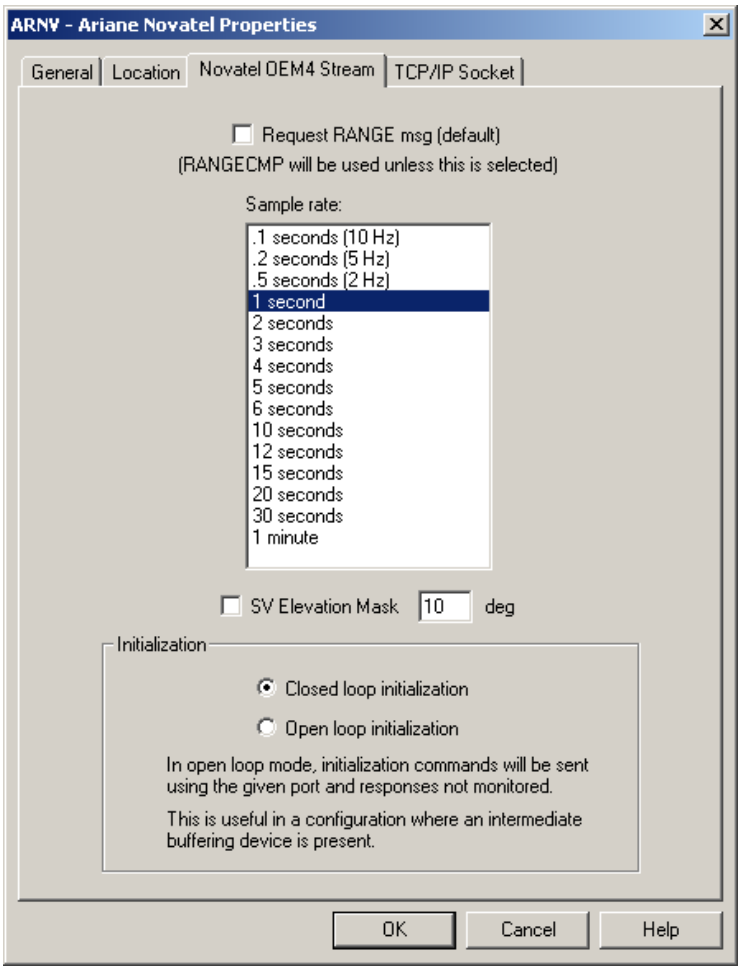

Figure 45 – Novatel OEM4 Stream Property Page

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Field descriptions:

Observable Message

Novatel OEM4 receivers provide two types of measurement message, normal (RANGE) and compressed (RANGECMP). The compressed version is smaller but the accuracy of the measurements will be degraded slightly. Use the compressed version of the message if bandwidth is an issue.

Sample Rate

Select the rate at which data are to be sampled. GeoRTD will automatically configure the receiver to stream out data at the specified sample rate.

SV Elevation Mask

Enable this to have GeoRTD set the selectable elevation mask in the receiver when initializing the receiver.

Initialization

Choose the initialization mode to be used. GeoRTD attempts to initialize the receiver each time it is connected to it. In closed loop initialization it will issue commands and listen for responses, generating an alarm if the responses are invalid or not present. In open loop initialization, the commands will be sent but responses not verified. Open loop initialization is necessary to accommodate intermediate devices in some cases, such as data buffers outside but connected to a receiver.

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6.2.5 Site Properties: SiRF SBP Stream Property Page

Use this dialog to specify the properties of the SiRF SBP (L1 only SiRF Binary Protocol) data stream from a site.

Applicable Network Types: Real-time

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears, then, select the “SBP Stream” tab on the site properties window.

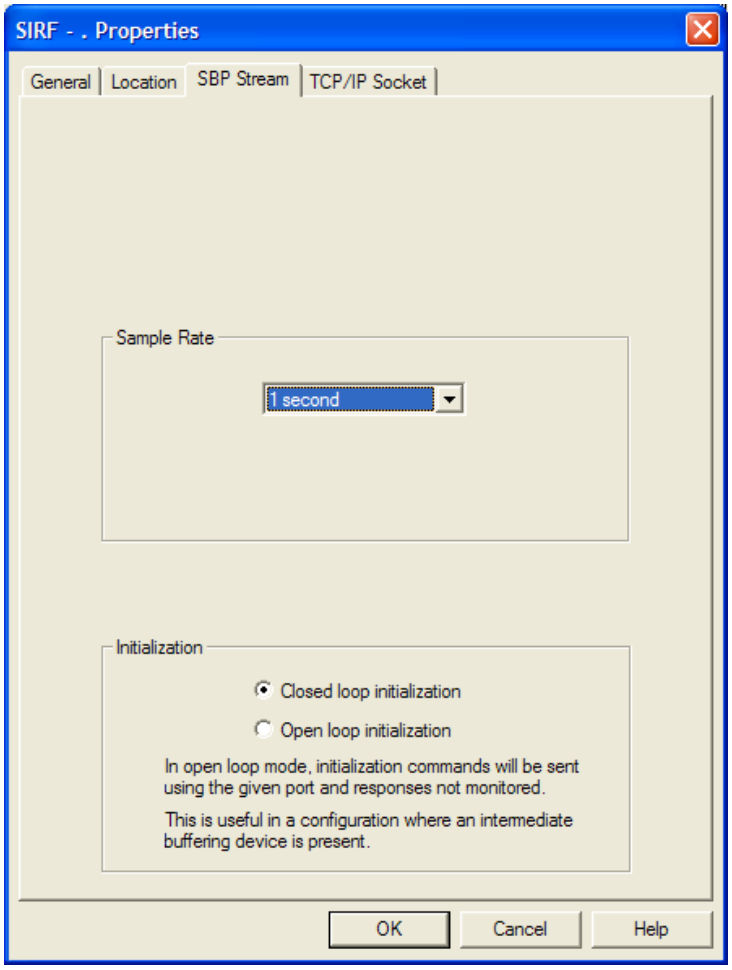

Figure 46 – SiRF SBP Stream Property Page

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Field descriptions:

Sample Rate

Select the rate at which data are to be sampled. GeoRTD will automatically configure the receiver to stream out data at the specified sample rate.

Initialization

Choose the initialization mode to be used. GeoRTD attempts to initialize the receiver each time it is connected to it. In closed loop initialization it will issue commands and listen for responses, generating an alarm if the responses are invalid or not present. In open loop initialization, the commands will be sent but responses not verified. Open loop initialization is necessary to accommodate intermediate devices in some cases, such as data buffers outside but connected to a receiver.

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6.2.6 Site Properties: Topcon GRIL Stream Property Page

Use this dialog to specify the properties of the Topcon GRIL data stream from a site.

Applicable Network Types: Real-time

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears, then, select the “Topcon GRIL Stream” tab on the site properties window.

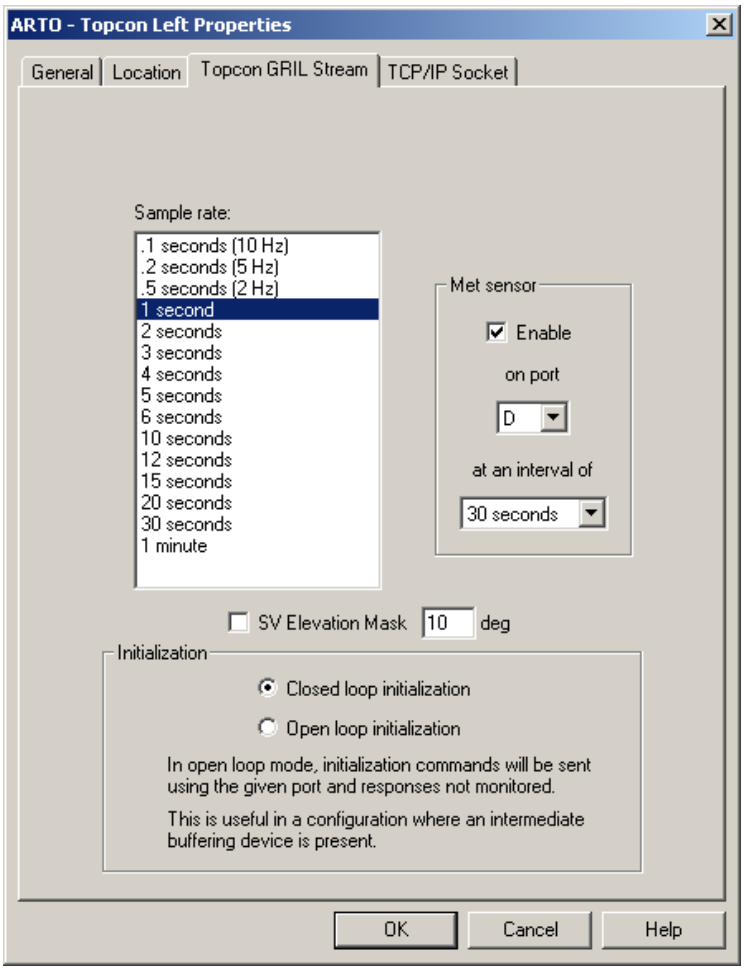

Figure 47 – Topcon GRIL Stream Property Page

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Field descriptions:

Sample Rate

Select the rate at which data are to be sampled from this site, and select the type of receiver that will be broadcasting data (check the appropriate radio button). GeoRTD will automatically configure the receiver to stream out data at the specified sample rate.

Met sensor

These options are used if a met sensor is present. Enable and set the port to which the met sensor is connected, and how often the met sensor is to be polled for data.

SV Elevation Mask

Enable this to have GeoRTD set the selectable elevation mask in the receiver when initializing the receiver.

Initialization

Choose the initialization mode to be used. GeoRTD attempts to initialize the receiver each time it is connected to it. In closed loop initialization it will issue commands and listen for responses, generating an alarm if the responses are invalid or not present. In open loop initialization, the commands will be sent but responses not verified. Open loop initialization is necessary to accommodate intermediate devices in some cases, such as data buffers outside but connected to a receiver.

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6.2.7 Site Properties: Trimble RT17 Stream Property Page

Use this dialog to specify the properties of the RT17 data stream from a site. Note that for Trimble NetRS receivers there is an additional menu tab for initialization control (described below).

Applicable Network Types: Real-time

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears, then, select the “Trimble RT17 Stream” tab on the site properties window.

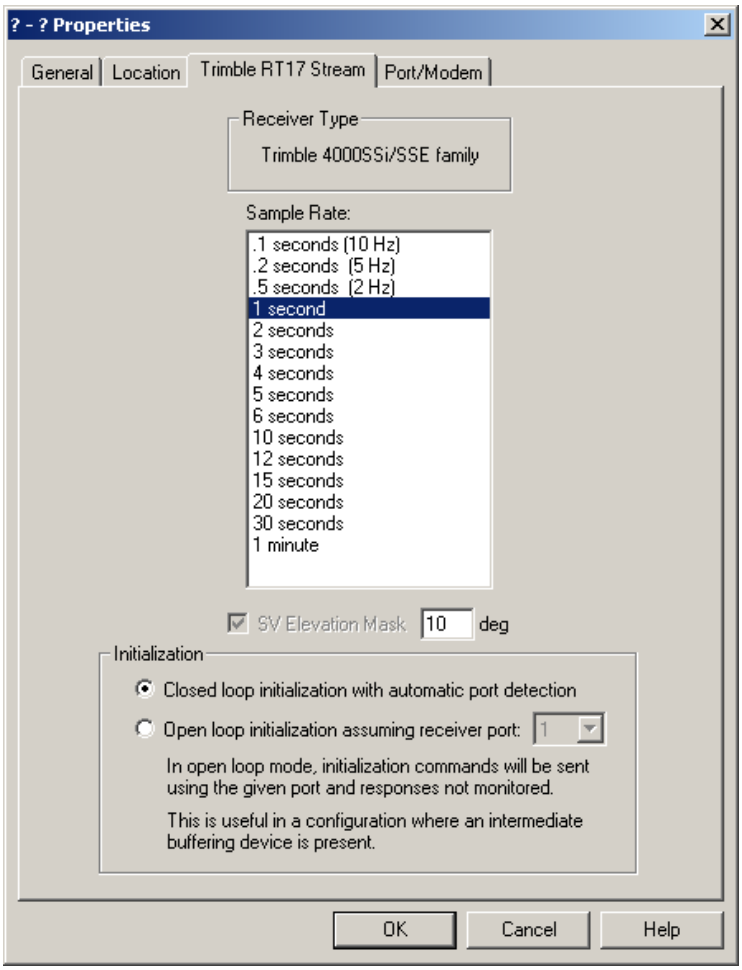

Figure 48 – Trimble RT17 Stream Property Page

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Field descriptions:

Sample Rate
Select the rate at which data are to be sampled. GeoRTD will automatically configure the receiver to stream out data at the specified sample rate.

SV Elevation Mask
Enable this to have GeoRTD set the selectable elevation mask in the receiver when initializing the receiver. Note that for the older Trimble models (SSE/SSI) this setting cannot be disabled.

Initialization
Choose the initialization mode to be used. GeoRTD attempts to initialize the receiver each time it is connected to it. In closed loop initialization it will issue commands and listen for responses, generating an alarm if the responses are invalid or not present. In open loop initialization, the commands will be sent but responses not verified. Open loop initialization is necessary to accommodate intermediate devices in some cases, such as data buffers outside but connected to a receiver.

For the Trimble NetRS, initialization is done on a separate TCP/IP connection. The open loop / closed loop initialization options aren't present and a separate configuration tab exists:

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6.2.8 Site Properties: Trimble RT17 Stream Initialization Control Property Page

This is the additional menu tab for initialization control.

Applicable Network Types: Real-time (with a Trimble NetRS)

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears, then, select the “Trimble RT17 Stream” tab on the site properties window. For the Trimble NetRS, initialization is done on a separate TCP/IP connection. The open loop / closed loop initialization options aren’t present and a separate configuration tab exists:

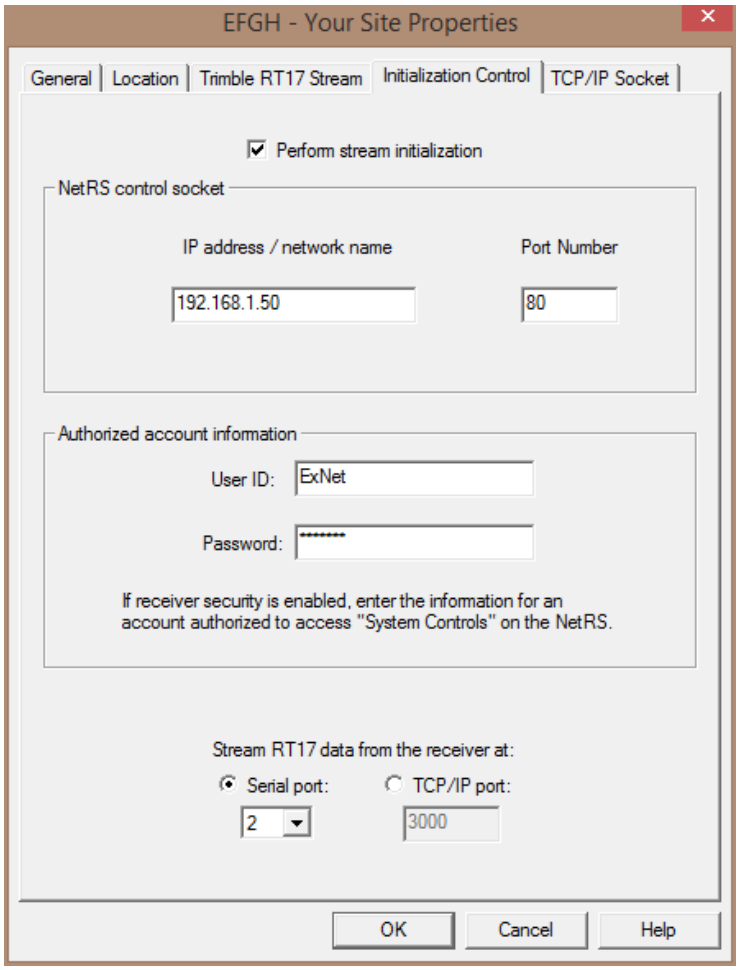

Figure 49 – Trimble NetRS Stream Initialization Control

<u>Perform stream initialization</u>

If this feature is enabled, GeoRTD will attempt to send stream initialization commands to the NetRS control socket specified on this page. If disabled GeoRTD will connect to the receiver without sending initialization commands. In this case the NetRS has hopefully already been configured for RT17 output by some other means.

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NetRS control socket
Enter the location where the NetRS will be listening for control commands. The default for the NetRS is port 80, but this may have been changed by the receiver administrator or by firewall settings.

Authorized account information
If receiver security is enabled, you may enter the authorization information here.

Stream RT17 data from the receiver at
Choose the serial port or TCP/IP port where the receiver should output RT17 data.

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6.3 Communication Link Site Properties

6.3.1 Site Properties: Serial Port Property Page

Use this dialog to configure an RS-232 or modem communication link to a receiver. (This dialog only appears if the communication link to a site was specified to be an RS232 connection or a modem connection).

Applicable Network Types: Real-time

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu which then appears; then, select the “Port/Modem” tab on the site properties window. This dialog only appears for sites in a Real-time mode network that is using an RS-232 (serial line) or modem connection to communicate with a receiver.

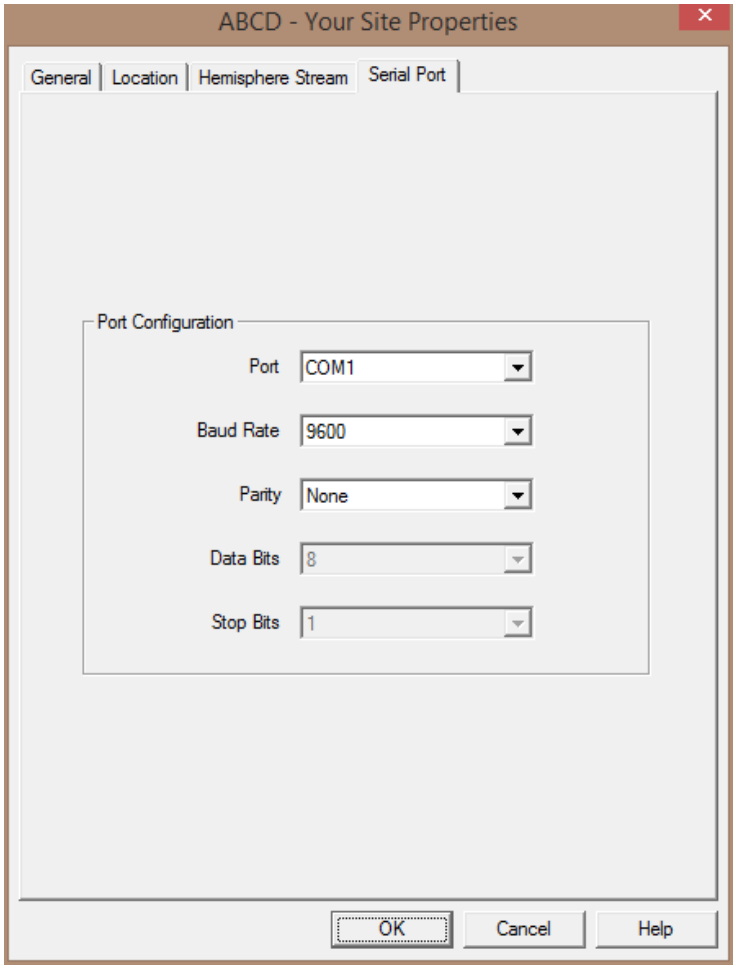

Figure 50 – Serial Port Property Page

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Field descriptions:

Port Configuration

The Port field is used to specify the serial port through which GeoRTD will communicate with the site. Set the Baud Rate and Parity fields to match the baud rate and parity of the receiver. The Data Bits and Stop Bits fields are all fixed to a default configuration.

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6.3.2 Site Properties: TCP/IP Socket Property Page

Use this dialog to configure the TCP/IP communications link between GeoRTD and the site.

Applicable Network Types: Real-time

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu; then, select the “TCP/IP Socket” tab on the site properties window. This dialog only appears for sites in a Real-time mode that is using a TCP/IP network connection to communicate with a receiver.

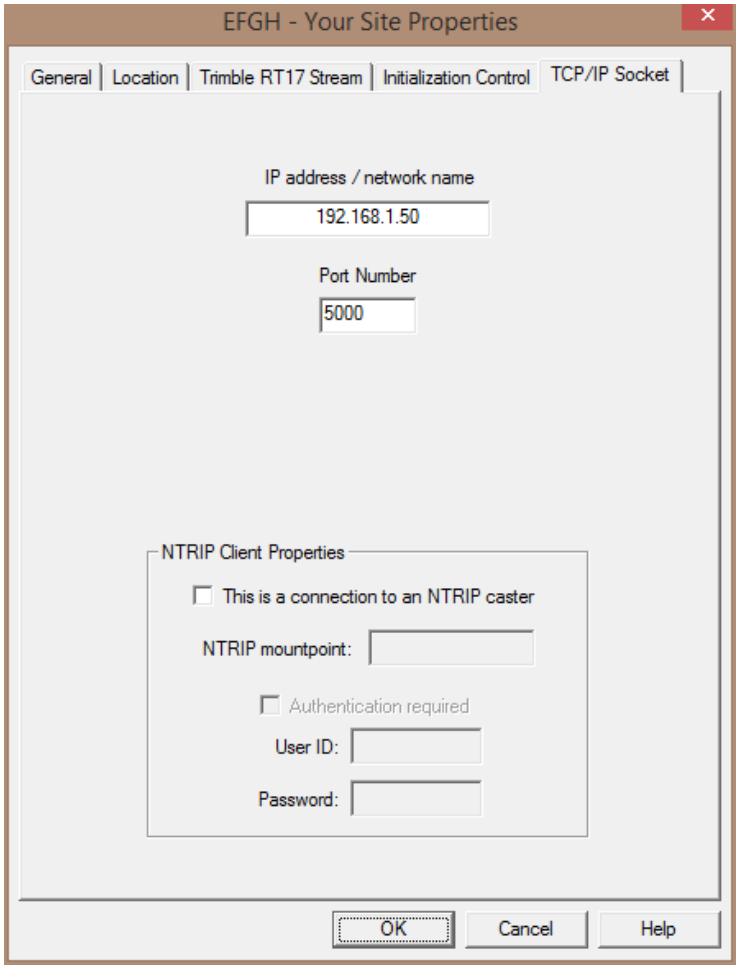

Figure 51 – TCP/IP Socket Property Page

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Field descriptions:

IP ADDRESS
Enter the *IP address* and *Port* number that GeoRTD should use to communicate with the receiver.

NTRIP Client Properties
If the address specified above is that of an NTRIP caster, check: "*This is a connection to an NTRIP caster"* and use these fields to enter the information necessary to attach to the receiver as an NTRIP client.

NTRIP mountpoint
Enter the mountpoint name for the desired receiver/site as provided by the NTRIP caster. GeoRTD will allow entry of up to 20 alphanumeric characters.

Authentication required
If the NTRIP caster requires authentication, check this box and enter the user id and password you would like GeoRTD to present to the NTRIP caster when connecting to the site.

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6.3.3 Site Properties: UDP Socket Property Page

Use this dialog to configure the TCP/IP communications link between GeoRTD and the site.

Applicable Network Types: Real-time

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu; then, select the “TCP/IP Socket” tab on the site properties window. This dialog only appears for sites in a Real-time mode that is using a TCP/IP network connection to communicate with a receiver.

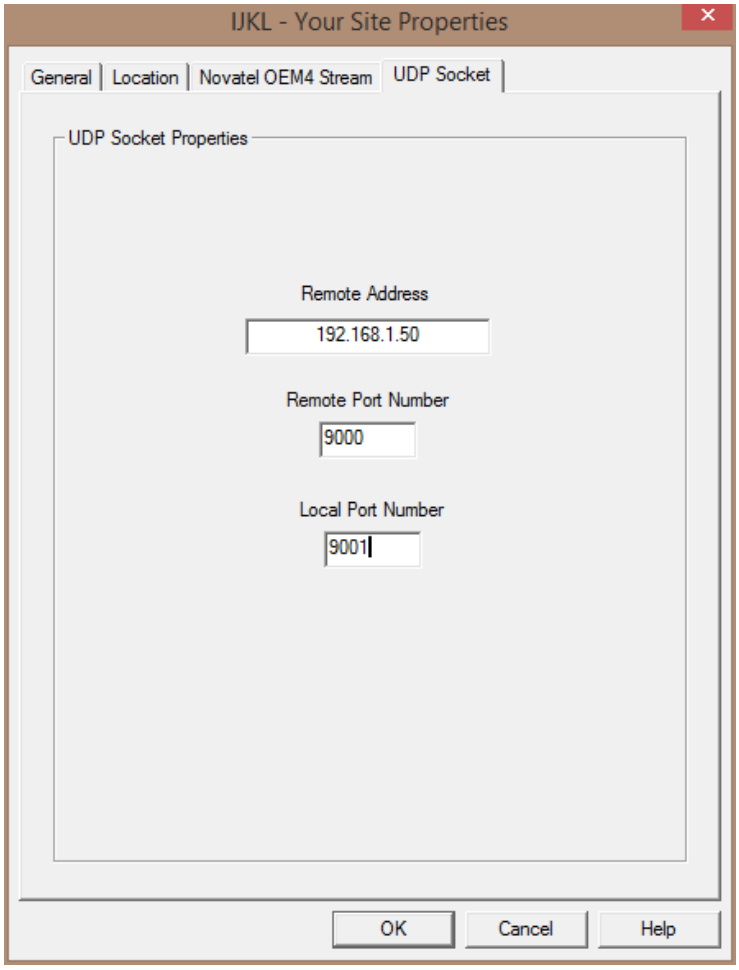

Figure 52 – UDP Socket Property Page

Field descriptions:

Remote Address
Enter the *IP address* and *Port* number that GeoRTD should use to communicate with the receiver.

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6.4 Post-processing Property Pages

6.4.1 Site Properties: Filtering Property Page

Applicable Network Types: Post-processing

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu; then, select the “Filtering” tab on the site properties window. This dialog only appears for sites in a Post-processing network.

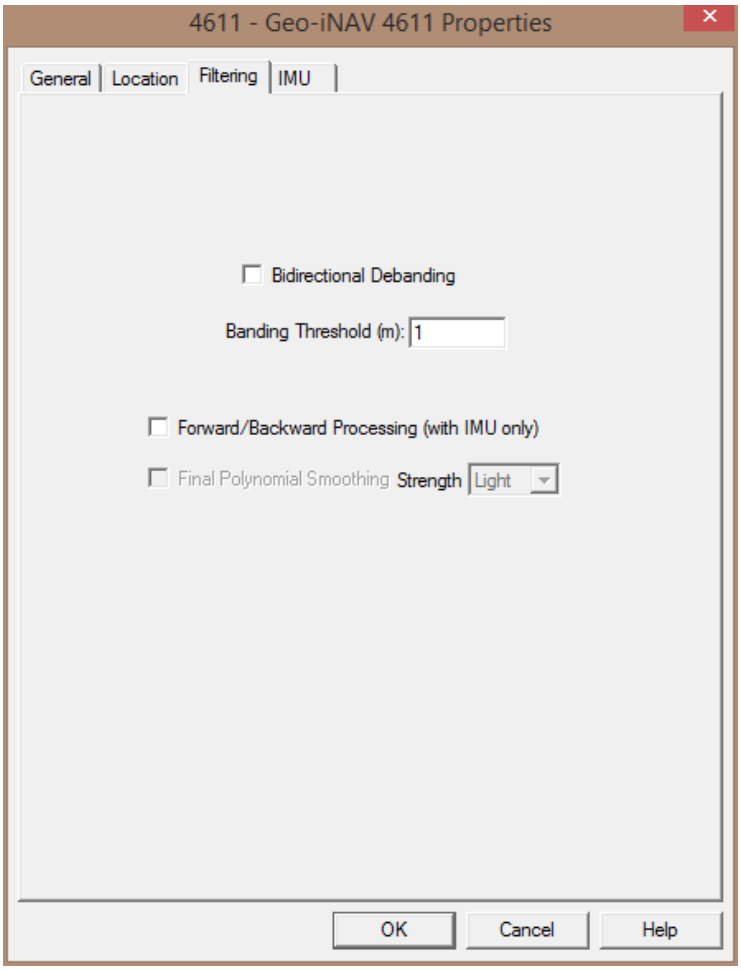

Figure 53 – Filtering Property Page

Field descriptions:

Bidirectional Debanding
Aligns displaced tracts of GPS positions with the general trend.

Banding Threshold: Threshold above which a tract of GPS positions is considered displaced from the general trend.

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Forward/Backwards Processing
Performs forward and reverse GPS/IMU processing and combines them for better performance across long GPS outages.

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6.4.2 Site Properties: IMU Property Page

Configure IMU properties.

Applicable Network Types: Post-processing

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu; then, select the “IMU” tab on the site properties window. This dialog only appears for sites in a Post-processing network.

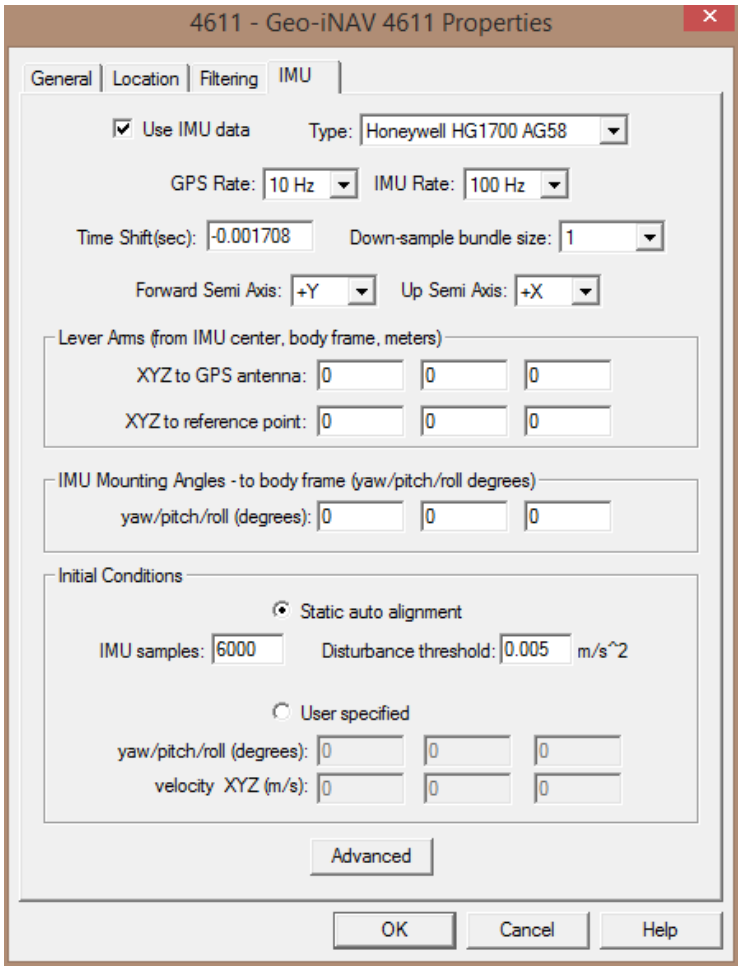

Figure 54 – IMU Property Page

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6.4.3 Site Properties: Advanced IMU Property Page

Configure advanced IMU properties.

Applicable Network Types: Post-processing

To Access: Double-click the site in the GeoRTD site window, or right-click on the site in the site window and select “Properties” from the popup menu, select the “IMU” tab then select the “Advanced” button at the bottom of the site properties window. This dialog only appears for sites in a Post-processing network.

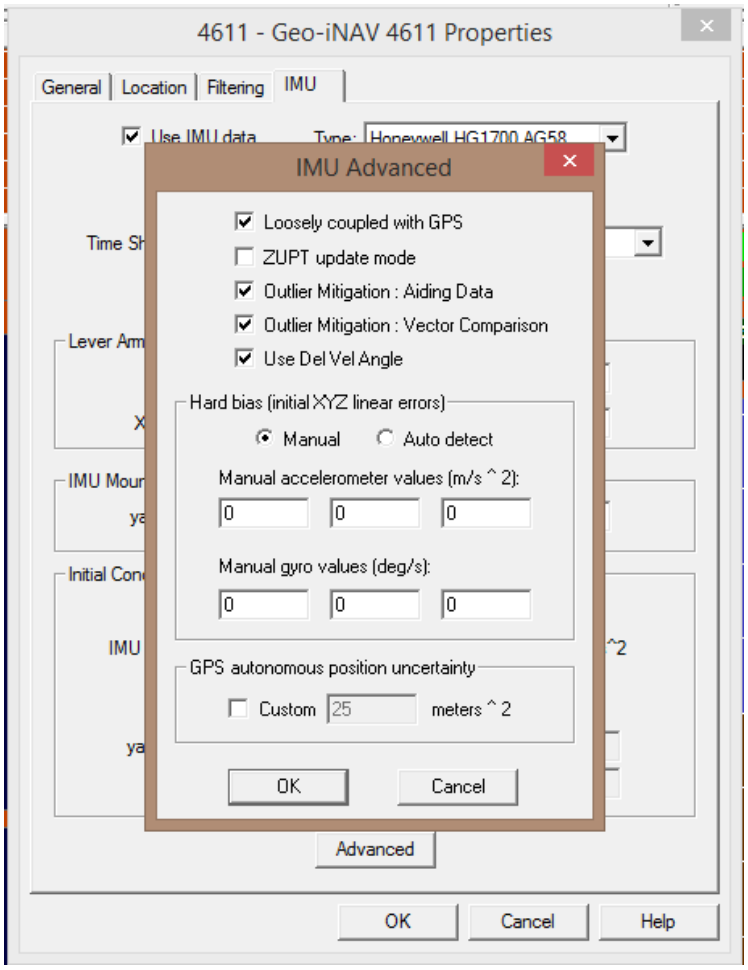

Figure 55 – IMU Advanced Property Page

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7.0 GeoRTD Global Settings

Global GeoRTD properties and information apply to all GeoRTD networks, and are edited via the GeoRTD global settings dialog. This dialog has several different property pages, with each page allowing access to different global information. The global settings dialog is reached by selecting the GeoRTD menu item “Tools/Global Data”.

The global settings database contains configuration parameters for an installation of GeoRTD. It also has provisions for a user-defined database of sites that are available to be used and re-used when constructing network definitions in GeoRTD. The information for sites contained in this database consists of a site code and name as well as location coordinates.

The following property pages are available to interact with the global settings:

Property Page Name	Function
Global Settings	General settings such as coordinate systems, background color and starting modes for post-processing and GNS playback.
TCP/IP	Set the TCP/IP global keep-alive timer.
Site Info	Interact with GeoRTD’s site information database. Edit information for an existing site, or add another site definition.
Receiver Types	Edit the receiver types and families that appear in GeoRTD menus.

Table 12 – Global Settings

For more details about these dialogs, please see below.

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7.1 GeoRTD Global Settings: Global Settings Property Page

This dialog has various global settings for GeoRTD.

To Access: Select the GeoRTD main menu item “Tools/Global Data”; then select the “Global Settings” tab.

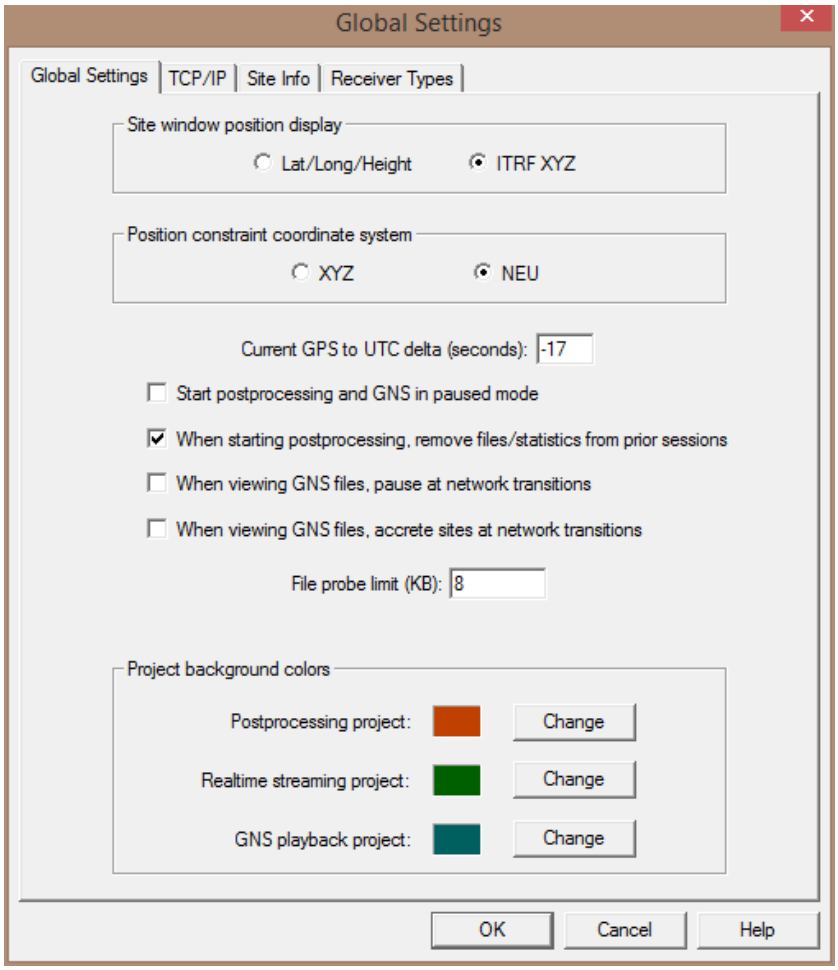

Figure 56 – Global Settings Property Page

Field descriptions:

<u>Site window position display</u>
Choose the format for site locations in the Site Properties/Location menu; either latitude/longitude/height or ITRF XYZ.

<u>Position Constraint Coordinate System</u>
Set the coordinate system for site constraints on the Site Properties/Location menu.

<u>Current GPS to UTC delta</u>

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This value denotes the number of whole seconds to add to GPS time when converting to UTC time. This important value should be updated when a leap second is added by the International Earth Rotation Service.

Post-processing and GNS Playback Options

There are several options for post-processing and GNS playback. Both may be started in a paused state and the post-processing playback toolbar buttons may then be used to continue processing or playback.

Important: By default, all generated files are deleted at the beginning of a post-processing run; that behavior may be over-ridden here. Post-processing may be used to generate RINEX files from raw data and record GNS files. Since the names of the generated files will remain constant, and a post-processing experiment may be run several times with different options set, all previously generated RINEX and GNS files are removed by default when starting a new post-processing run. There are cases where you may want to modify this behavior. An example would be a post-processing configuration that is used to convert binary data from an external source to RINEX on a weekly basis, accruing the converted RINEX files.

Two options are given for GNS playback to provide for networks that are changing frequently. An example of this is GeoRTD running as a smart client with a local receiver which is mobile, and the option set to have the server use the "n" closest reference sites. As the client moves around, the server will switch the reference sites for the client to maintain the closest ones. GNS files recorded on the client in this case will have frequent occurrences of reference sites appearing and disappearing. To make GNS playback usable from a configuration like this, the network can be automatically paused each time a site is switched in or out of the network *("…pause at network transitions")*, and/or sites can be accumulated on the displays even when they are not in the network at a given epoch *("…accrete sites at network transitions").*

Project background colors

Default background colors for different configuration types may be changed on this window.

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7.2 GeoRTD Global Settings: TCP/IP Property Page

This window allows the TCP/IP keep-alive timeout to be set. This is a global value of the Windows TCP/IP networking stack; if it is modified, the new value will not take effect until the workstation is rebooted. The Microsoft default is 7200 seconds, however, it is recommended that this value be set to 300 seconds or less.

To Access: Select the GeoRTD main menu item “Tools/Global Data”; then select the “TCP/IP” tab on the global settings dialog.

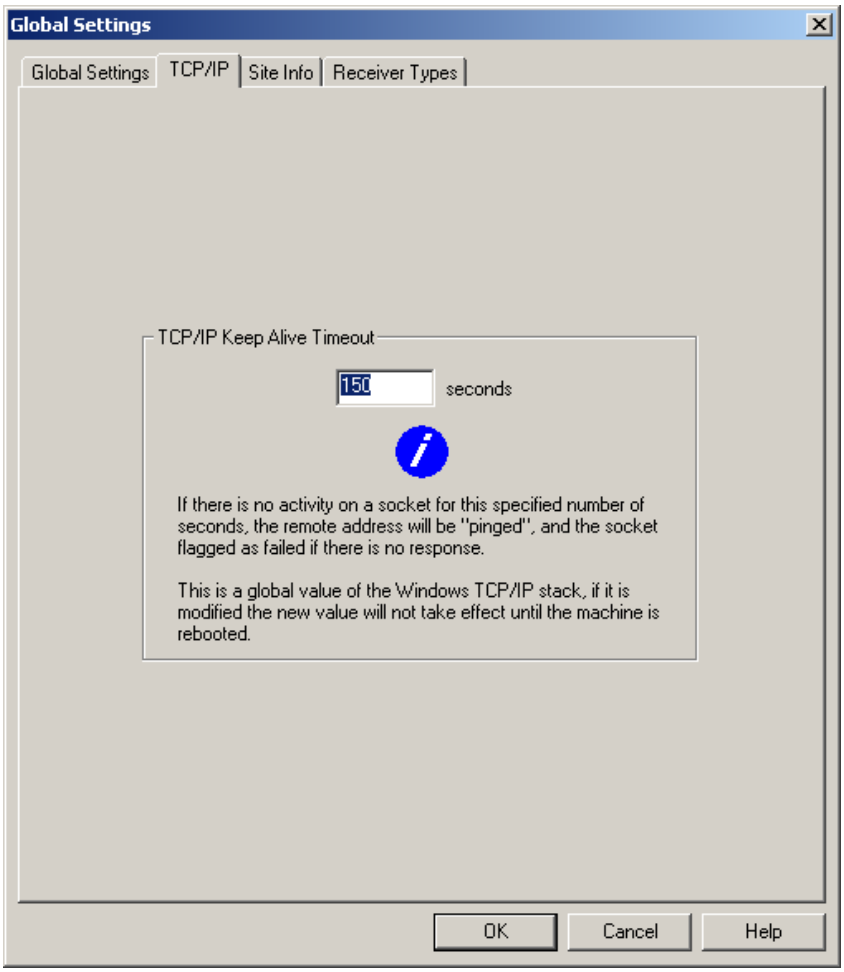

Figure 57 – Global Settings: TCP/IP Property Page

Explanation

If there is no activity on a socket for the specified number of seconds, the remote address will be “pinged”, and the socket flagged as failed if there is no response. If a device on the remote end of a TCP/IP connection encounters an error, such as if it is powered off or the network cable is disconnected, GeoRTD will have no way of determining that. TCP/IP was designed to attempt to hold connections together until a problem is corrected, at which time the connection would resume. This is probably not desired for live GeoRTD receiver networks; it would be more desirable to know as quickly as possible if a problem occurs so it can be identified and corrected.

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So this setting causes the GeoRTD PC to ping a TCP/IP connection if no data has been received for the specified amount of time. If the ping fails, TCP/IP will notify GeoRTD that the there is a problem with the connection, and GeoRTD will generate an alarm and periodically attempt to re-establish the connection.

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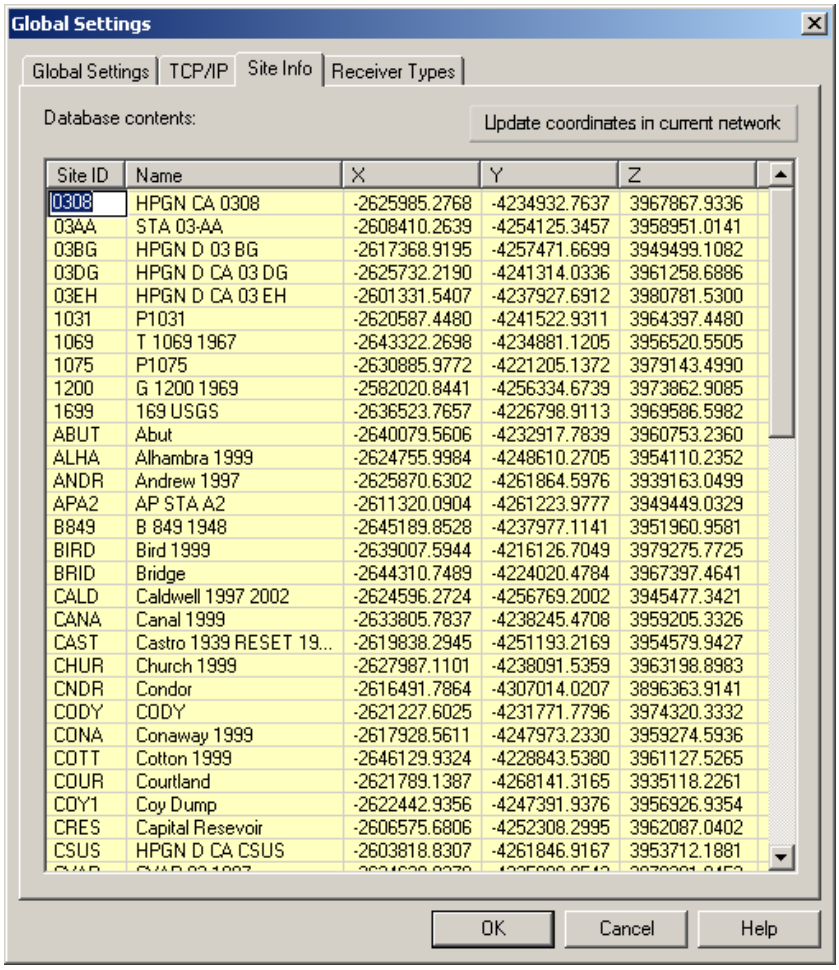
7.3 GeoRTD Global Settings: Site Info Property Page

This dialog allows the user to interface with the site information database. Sites are listed by code and name with their corresponding coordinates (ITRF XYZ in meters). Once information for a site is entered in this site information database, it may be pulled easily into Site Properties when defining a new GeoRTD configuration. This eliminates the need to manually enter ITRF coordinates for sites that are used repeatedly in different GeoRTD configuration.

To Access: Select the GeoRTD main menu item “Tools/Global Data”; then select the “Site Info” tab on the global settings dialog.



Site ID	Name	X	Y	Z
0308	HPGN CA 0308	-2625985.2768	-4234932.7637	3967867.9336
03AA	STA 03-AA	-2608410.2639	-4254125.3457	3958951.0141
03BG	HPGN D 03 BG	-2617368.9195	-4257471.6699	3949499.1082
03DG	HPGN D CA 03 DG	-2625732.2190	-4241314.0336	3961258.6886
03EH	HPGN D CA 03 EH	-2601331.5407	-4237927.6912	3980781.5300
1031	P1031	-2620587.4480	-4241522.9311	3964397.4480
1069	T 1069 1967	-2643322.2698	-4234881.1205	3956520.5505
1075	P1075	-2630885.9772	-4221205.1372	3979143.4990
1200	G 1200 1969	-2582020.8441	-4256334.6739	3973862.9085
1699	169 USGS	-2636523.7657	-4226798.9113	3969586.5982
ABUT	Abut	-2640079.5606	-4232917.7839	3960753.2360
ALHA	Alhambra 1999	-2624755.9984	-4248610.2705	3954110.2352
ANDR	Andrew 1997	-2625870.6302	-4261864.5976	3939163.0499
APA2	AP STA A2	-2611320.0904	-4261223.9777	3949449.0329
B849	B 849 1948	-2645189.8528	-4237977.1141	3951960.9581
BIRD	Bird 1999	-2639007.5944	-4216126.7049	3979275.7725
BRID	Bridge	-2644310.7489	-4224020.4784	3967397.4641
CALD	Caldwell 1997 2002	-2624596.2724	-4256769.2002	3945477.3421
CANA	Canal 1999	-2633805.7837	-4238245.4708	3959205.3326
CAST	Castro 1939 RESET 19...	-2619838.2945	-4251193.2169	3954579.9427
CHUR	Church 1999	-2627987.1101	-4238091.5359	3963198.8983
CNDR	Condor	-2616491.7864	-4307014.0207	3896363.9141
CODY	CODY	-2621227.6025	-4231771.7796	3974320.3332
CONA	Conaway 1999	-2617928.5611	-4247973.2330	3959274.5936
COTT	Cotton 1999	-2646129.9324	-4228843.5380	3961127.5265
COUR	Courtland	-2621789.1387	-4268141.3165	3935118.2261
COY1	Coy Dump	-2622442.9356	-4247391.9376	3956926.9354
CRES	Capital Resevoir	-2606575.6806	-4252308.2995	3962087.0402
CSUS	HPGN D CA CSUS	-2603818.8307	-4261846.9167	3953712.1881

Figure 58 – Global Settings: Site Info Property Page

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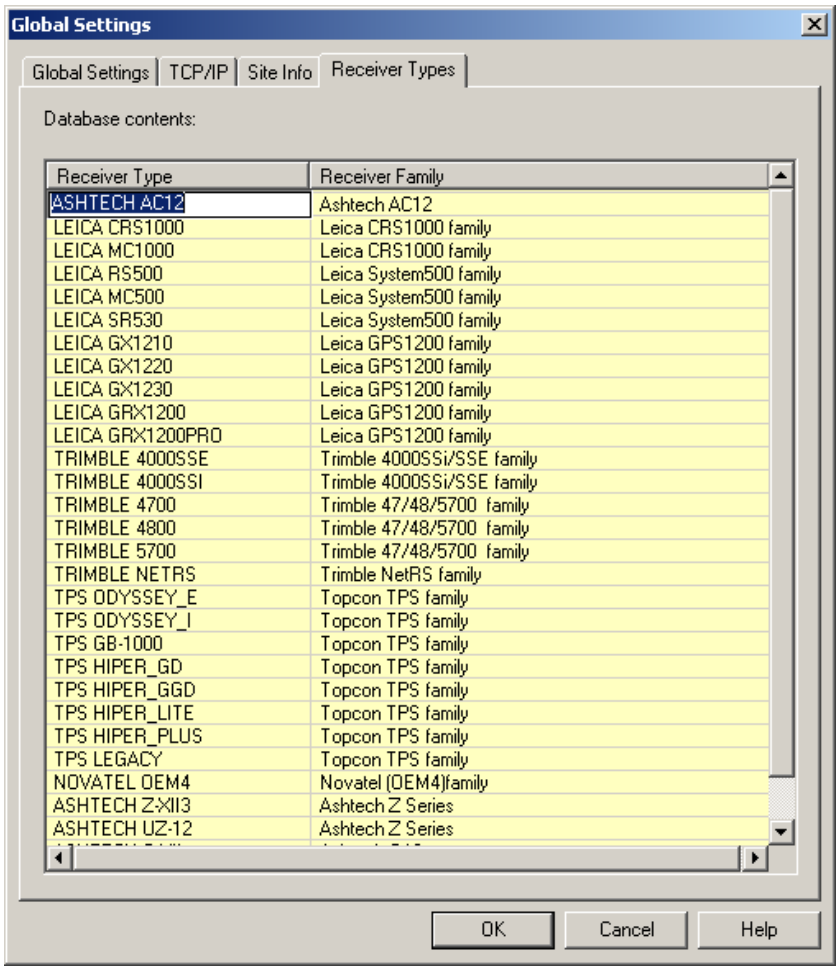
7.4 GeoRTD Global Settings: Receiver Types Property Page

This dialog allows the user to modify the receiver types and families. The receiver types for individual sites are set on the Site Properties/General window for the site. These descriptors are used to populate RINEX file headers. Use this window to add more receiver types if the equipment you are using is not in the default set but is supported by GeoRTD.

To Access: Select the GeoRTD main menu item “Tools/Global Data”; then select the “Receiver Types” tab on the global settings dialog.



Receiver Type	Receiver Family
ASHTECH AC12	Ashtech AC12
LEICA CRS1000	Leica CRS1000 family
LEICA MC1000	Leica CRS1000 family
LEICA RS500	Leica System500 family
LEICA MC500	Leica System500 family
LEICA SR530	Leica System500 family
LEICA GX1210	Leica GPS1200 family
LEICA GX1220	Leica GPS1200 family
LEICA GX1230	Leica GPS1200 family
LEICA GRX1200	Leica GPS1200 family
LEICA GRX1200PRO	Leica GPS1200 family
TRIMBLE 4000SSE	Trimble 4000SSi/SSE family
TRIMBLE 4000SSI	Trimble 4000SSi/SSE family
TRIMBLE 4700	Trimble 47/48/5700 family
TRIMBLE 4800	Trimble 47/48/5700 family
TRIMBLE 5700	Trimble 47/48/5700 family
TRIMBLE NETRS	Trimble NetRS family
TPS ODYSSEY_E	Topcon TPS family
TPS ODYSSEY_I	Topcon TPS family
TPS GB-1000	Topcon TPS family
TPS HIPER_GD	Topcon TPS family
TPS HIPER_GGD	Topcon TPS family
TPS HIPER_LITE	Topcon TPS family
TPS HIPER_PLUS	Topcon TPS family
TPS LEGACY	Topcon TPS family
NOVATEL OEM4	Novatel (OEM4)family
ASHTECH Z-XII3	Ashtech Z Series
ASHTECH UZ-12	Ashtech Z Series

Figure 59 – Global Settings: Receiver Types Property Page

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8.0 GeoRTD Menu Commands

8.1 GeoRTD Main Menu Commands

This section describes the commands in GeoRTD's main menu. There are five submenus on GeoRTD's main menu: File, View, Network, Tools, and Help.

8.1.1 File submenu commands

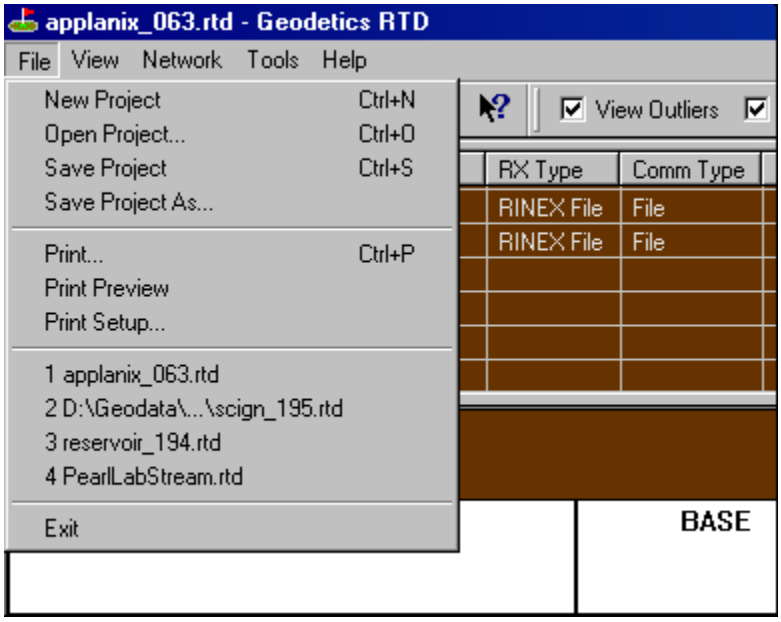

Figure 60 – File Submenu Commands

Menu Command	Description
New Project	Creates a new project (configuration file).
Open Project	Opens an existing project (configuration file).
Save Project	Saves the current project (configuration file) to the current file name.
Save Project As	Saves the current project (configuration file) to a new file name.
Print	Prints the contents of GeoRTD's screen graphics window.
Print Preview	Displays the document on the screen, as it would appear printed.
Print Setup	Selects a printer and printer connection.
1,2,3,4	Opens one of the four most recently used project files.
Exit	Exits GeoRTD application.

Table 13 – File Submenu Commands

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8.1.1.1 File Submenu: New Project command

Use this command to create a new project (configuration file). A project describes a particular network configuration including network geometry and data downloading, analysis, display and archiving options. The user can save the full network configuration in a project file identified by the .GeoRTD extension (e.g., aircraft_063.GeoRTD).

You can create a new project by starting with an existing project file, using the **Save Project As** command, and editing the file. *Be careful to enter or check all settings for the new project.* As you create a new project you can use the **Save Project** command to save your settings up to that point. You can open an existing project with the **Open Project** command.

Shortcuts:

Toolbar: Keys: '**CTRL+N**'

8.1.1.2 File Submenu: Open Project command

Use this command to open an existing project. Project files are identified by the default .GeoRTD extension or any other user-specified extension. Use the numbers and filenames listed near the bottom of the File menu to open any of the last four project files you worked on. You can create new projects with the **New Project** command.

Shortcuts:

Toolbar: Keys: '**CTRL+O**'

8.1.1.3 File Submenu: Save Project command

Use this command to save the active project to its current name and directory. When you save a project for the first time, GeoRTD displays the **Save Project As** dialog box so you can name your project. Files are automatically assigned an .GeoRTD extension. If you want to change the name and directory of an existing project before you save it, choose the **Save Project As** command.

Shortcuts:

Toolbar: Keys: '**CTRL+S**'

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8.1.1.4 File Submenu: Save Project As command

Use this command to save and name the active project. GeoRTD displays the **Save Project As** dialog box so you can rename your project and assign a new directory. To save a project with its existing name and directory, use the **Save Project** command.

Save Project As dialog box

The following options allow you to specify the name and location of the file you're about to save:

Save in: Select the directory in which you want to store the project file.

File Name: Enter a new filename to save a document with a different name.

Save as type: Specify the file extension (default: *.GeoRTD).

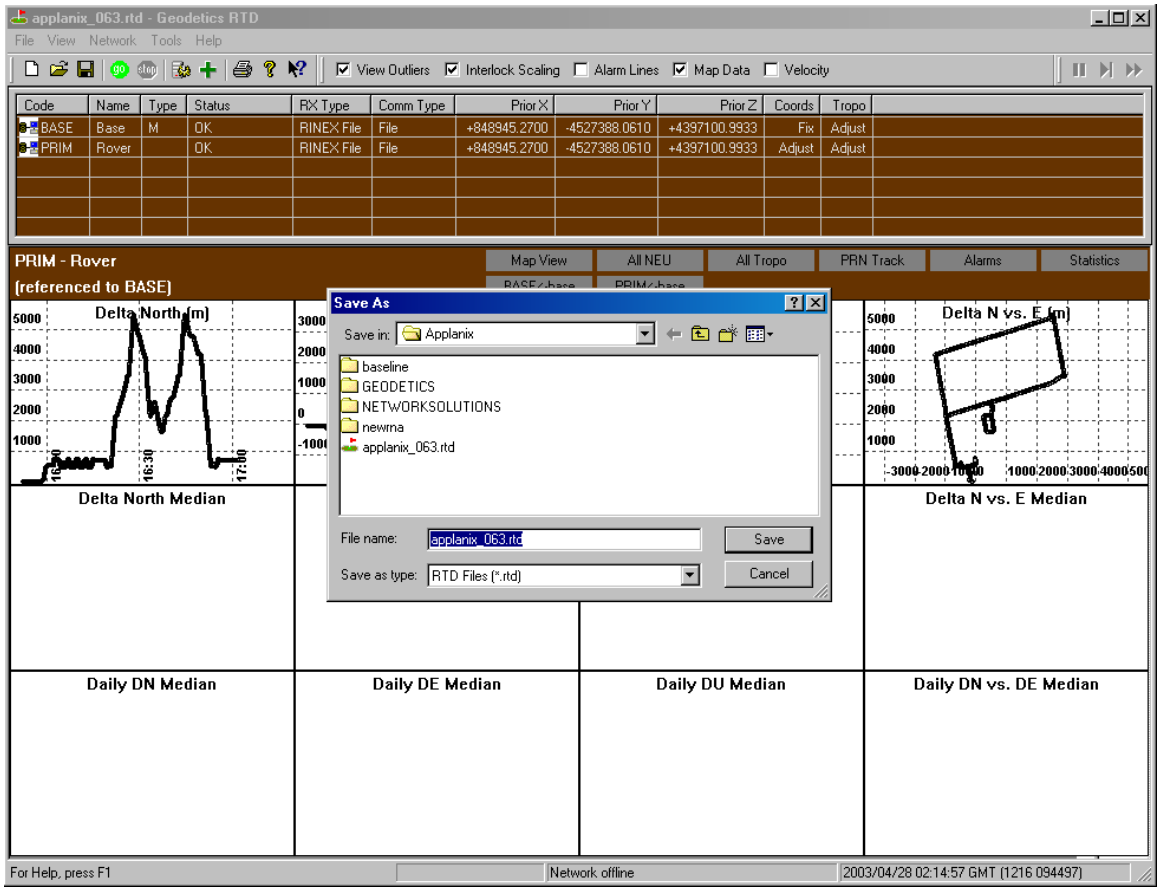

Figure 61 – Save Project As dialog box

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8.1.1.5 File Submenu: Print command

Use this command to print the contents of GeoRTD's screen graphics window. This command presents a **Print dialog box** (see below), where you may specify the range of pages to be printed, the number of copies, the destination printer, and other printer setup options.

Shortcuts:

Keys: '**CTRL+P**'

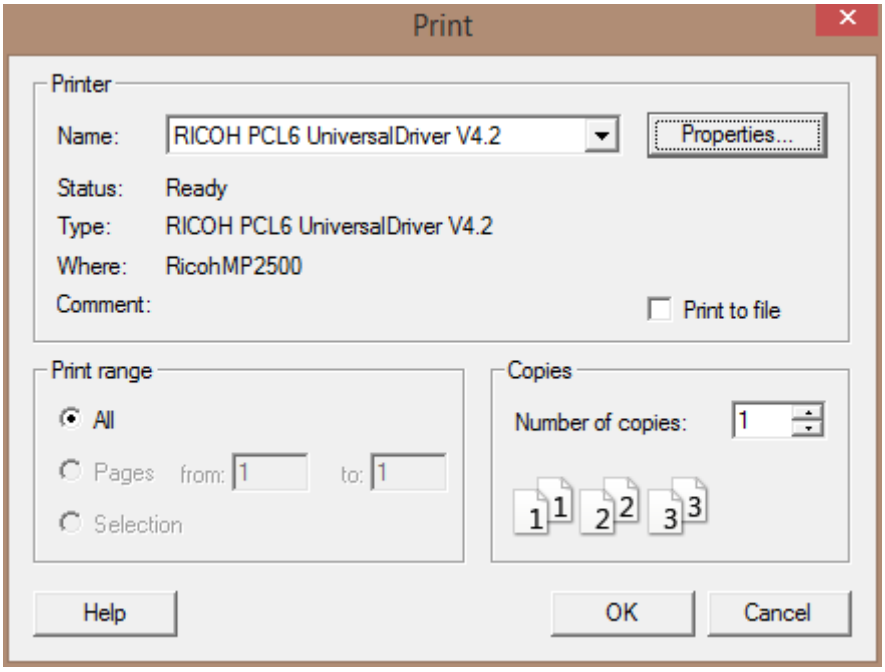

Figure 62 – Print Command

Print dialog box

The following options allow you to specify how the document should be printed:

Printer

This is the active printer and printer connection. Choose the Setup option to change the printer and printer connection.

Setup

Displays a Print Setup dialog box, for the user to select a printer and printer connection.

Print Range

Specify the pages you want to print:

All	Prints the entire document.
Selection	Prints the currently selected text.
Pages	Prints the range of pages you specify in the From and To boxes.

Copies

Specify the number of copies you want to print for the above page range.

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Collate Copies

Prints copies in page number order, instead of separated multiple copies of each page.

Print Quality

Select the quality of the printing. Generally, lower quality printing takes less time to produce.

Print Progress Dialog

The printing dialog box is shown during the time that GeoRTD is sending output to the printer. The page number indicates the progress of the printing.

To abort printing, enter Cancel.

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8.1.1.6 File Submenu: Print Preview command

Use this command to display the active document, as it would appear when printed. When you choose this command, the main window will be replaced with a print preview window in which one or two pages will be displayed in their printed format. The **print preview toolbar** offers you options to view either one or two pages at a time; move back and forth through the document; zoom in and out of pages; and initiate a print job.

Shortcuts:

Toolbar:

Print Preview toolbar

The print preview toolbar offers you the following options:

Print

Bring up the print dialog box, to start a print job.

Next Page

Preview the next printed page.

Prev Page

Preview the previous printed page.

One Page / Two Page

Preview one or two printed pages at a time.

Zoom In

Take a closer look at the printed page.

Zoom Out

Take a larger look at the printed page.

Close

Return from print preview to the editing window.

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8.1.1.7 File Submenu: Print Setup command

Use this command to select a printer and a printer connection. This command presents a **Print Setup** dialog box, where you specify the printer and its connection.

Print Setup dialog box
The following options allow you to select the destination printer and its connection.

Printer
Select the printer you want to use. Choose the Default Printer; or choose the Specific Printer option and select one of the current installed printers shown in the box. You install printers and configure ports using the Windows Control Panel.

Orientation
Choose Portrait or Landscape.

Paper Size
Select the size of paper that the document is to be printed on.

Paper Source
Some printers offer multiple trays for different paper sources. Specify the tray here.

Options
Displays a dialog box where you can make additional choices about printing, specific to the type of printer you have selected.

Network...
Choose this button to connect to a network location, assigning it a new drive letter.

Page Setup dialog box
Displays a Page Setup dialog box for defining page options for printing.

8.1.1.8 File Submenu: 1,2,3,4

Choose one of the numbers and filenames to open any of the last four project files you worked on.

8.1.1.9 File Submenu: Exit command

Use this command to end your GeoRTD session. You can also use the Close command on the application Control menu. GeoRTD prompts you to save documents with unsaved changes.

Shortcuts
Mouse: Right-click the application's Control menu button [top (blue) line of GeoRTD working environment] and choose ‘Close’.
Keys: ‘ALT+F4’

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8.1.2 View Submenu Commands

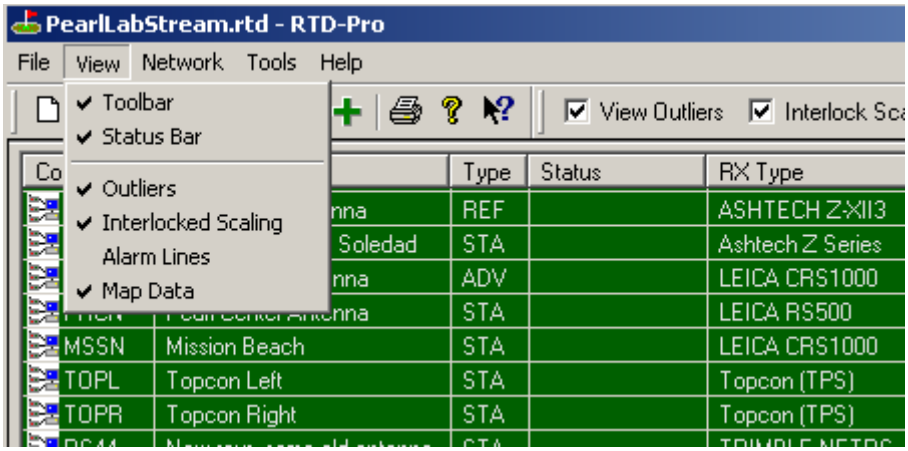

Figure 63 – Drop-down View Menu

The View submenu offers the following commands:

View Menu	Function
Toolbar	Shows or hides the toolbar.
Status Bar	Shows or hides the status bar.
Outliers	Shows or hides outliers on graphs.
Interlocked Scaling	When enabled, will interlock the scaling on the graphs displayed by GeoRTD.
Alarm Lines	Controls whether GeoRTD will display alarm thresholds on statistical graphs.
Map Data	Controls whether GeoRTD will display data for each site in the Map View.

Table 14 – View Menu

8.1.2.1 View Submenu: Toolbar command

Use this command to display or hide the Toolbar (shown below), which includes buttons for some of the most common commands in GeoRTD. A check mark appears next to the menu item when the Toolbar is displayed.

For more information, refer to the section titled “Description of GeoRTD’s Graphical User Interface” in this document..

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8.1.2.2 View Submenu: Status Bar command

Use this command to display and hide the Status Bar. A check mark appears next to the menu item when the Status Bar is displayed. For more information, refer to the section titled “Description of GeoRTD’s Graphical User Interface” in this document..

8.1.2.3 View Submenu: View Outliers command

Outliers will be displayed when this option is enabled. A check mark next to the View Outliers menu item indicates that the option is enabled. Clicking on the View Outliers box toggles the status of this option.

Small red crosses denote outliers. The outlier range is indicated on the horizontal scatter plots by purple lines. The range is always displayed, independent of the View Outliers option.

See section 2.11, “The meaning of outliers in GeoRTD (Static Mode Only)” in The GeoRTD Framework-Concepts and Definitions section for more information about outliers.

Shortcut: Click the “View Outliers” checkbox (located to right of toolbar).

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8.1.2.4 View Submenu: Interlocked Scaling command

This option enables interlocked scaling for screen graphics. A check mark next to the menu item indicates that the option is enabled. Clicking on the Interlocked Scaling box toggles the status of this option.

When interlocked scaling is enabled, the vertical axes of the data plots are constrained to have the same scale. Because vertical coordinate precision is considerably less than horizontal coordinate precision, the scatter in the vertical coordinates will determine the scale of the plots.

Shortcut: Click Interlocked Scaling checkbox (located to right of toolbar).

8.1.2.5 View Submenu: Alarm Lines command

This option enables display of Alarm lines on plots. A check mark next to the menu item indicates that the option is enabled. Clicking on the Alarm Lines box toggles the status of this option.

When the Alarm Lines option is enabled, the upper and lower limits of the alarm threshold for each coordinate (N, E, and U) will be shown on the GeoRTD graphics displays. Red lines depict the alarm thresholds. The alarm thresholds are defined by the user in section 5.5 “Network Configuration: Alarms Property Page”.

Note: Alarm lines will be displayed even if the alarm is disabled.

To Access: Click Alarm Lines checkbox (located to right of toolbar).

8.1.2.6 View Submenu: Map Data command

This option controls whether GeoRTD will display shift data for each site in the Map View. A check mark next to the menu item indicates that the option is enabled. Clicking on the Map Data box toggles the status of this option.

To Access: Click Map Data checkbox (located to right of toolbar).

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8.1.3 Network Submenu commands

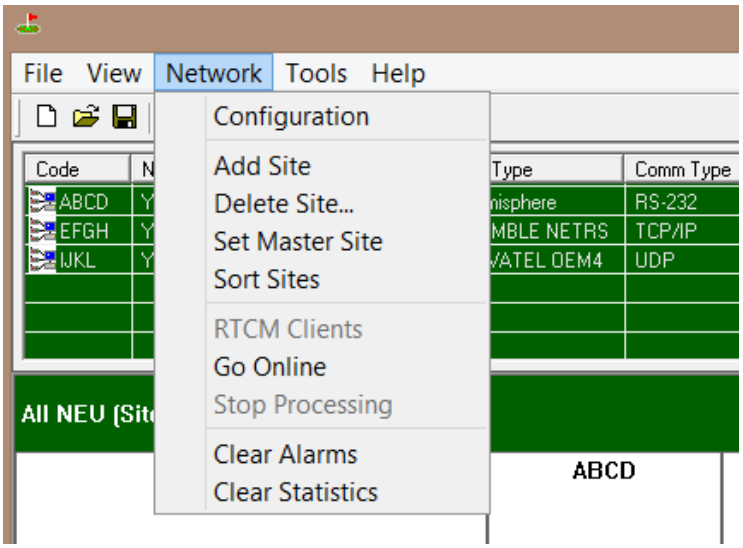

Figure 64 – Network Submenu

The Network submenu offers the following network-specific options:

Configuration	Sets the parameters for the network analysis.
Add Site	Adds a site to the network.
Delete Site	Deletes a site from the network.
Set Master Site	Defines a Master Site for the network.
Stop Processing	Stops processing network data.

Table 15 – Common network submenu items

Sort Sites	Sorts Sites
Go Online	Initiates network data collection, processing, and storage.
RTCM Clients	Shows window with lists of currently connected clients.
Clear Alarms	Clears the contents of the recent alarms window.
Clear Statistics	Clears the contents of the latest statistics window.

Table 16 – Real-time network submenu items

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Post-process	Initiates processing of files in a post processed network.
Pause	Pauses processing of files in a post processed network.
Continue	Continues processing of files in a post-processed network.
Step	Processes next epoch in a post-processed network.

Table 17 – Post-processing network submenu items

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8.1.3.1 Network Submenu: Configuration command

Use this command to access the Network Configuration window. This window allows access to all network configuration settings. It is discussed in detail in a previous section.

Shortcut: Toolbar:

8.1.3.2 Network Submenu: Add Site command

Use this command to add a site to an existing network, or to start creating a new network.

Shortcut: Toolbar:

8.1.3.3 Network Submenu: Delete Site command

Use this command to delete a site from the current network. The following window will be displayed to allow selection of the site to be deleted:

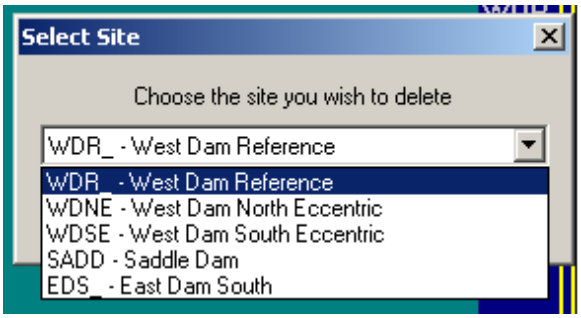

Figure 65 – Network: Delete Site List

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8.1.3.4 Network Submenu: Set Master Site command

Use this command to set or change the Master Site for the current network. Entering this command brings up the Select Site dialog window (see below). The order of sites will be re-arranged automatically so that the Master Site will always appear first in the list of network sites.

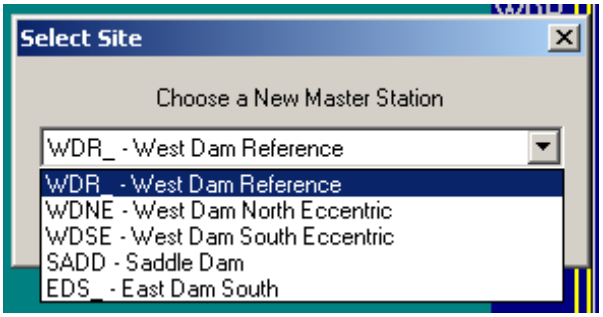

Figure 66 – Network: Set Master Site List

Background: One site in the network must be designated as the Master Site, or reference site. In general, the Master Site should have its coordinates fixed, serving as an absolute base receiver although this is not a requirement. The Master Site is not fixed when it and other network sites are in motion, and only relative positions are estimated.

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8.1.3.5 Network Submenu: Go Online/Post-Process command

Shortcut: Toolbar:

Use this command to start network data collection, processing, and storage. In post-processing mode or Real-time mode, data collection and processing begins immediately. For post-processing the contents of the selected files are loaded and processed. For Real-time mode connections to all receivers are made and then monitored for observation and ephemeris data from the receivers.

8.1.3.6 Network Submenu: Stop Processing command

Shortcut: Toolbar:

Use this command to stop processing. Any processing in progress will be aborted and all communication links to receiver or post-process files will be closed. Note that it may take several minutes to close the communication links for the network, such as disconnecting modem calls.

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8.1.3.7 Network Submenu: RTCM Clients

Use this command to access the RTCM Clients dialog. This dialog will display a list of all clients connected to the RTCM Standard Server, RTCM Enhanced Server, RTCM Smart Server and RYO Position Server.

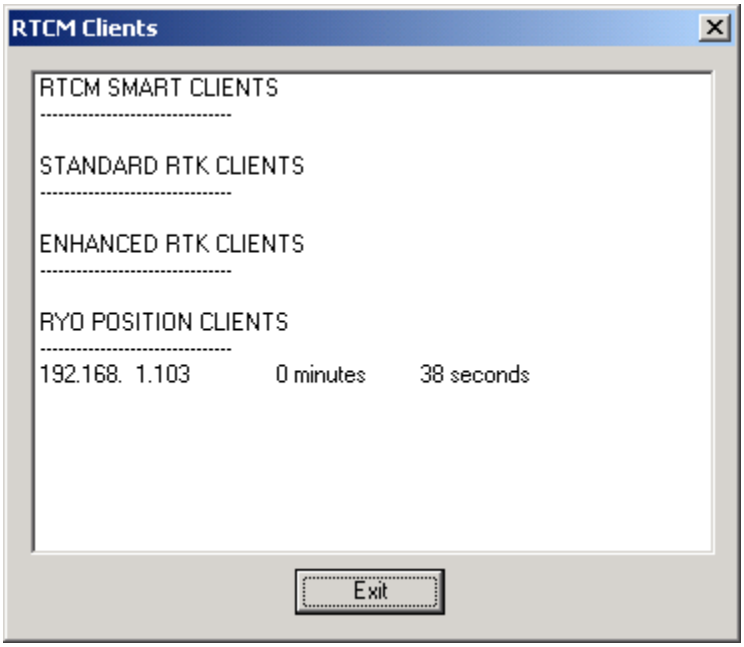

Figure 67 – RTCM/RYO Clients Dialog

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8.1.3.8 Network Submenu: Clear Alarms command

Use this command to clear the alarms display. This will not affect the contents of the alarms log file ("_alarms.txt").

8.1.3.9 Network Submenu: Clear Statistics command

Use this command to clear the statistics display. This will not affect the contents of the statistics log file ("_stats.txt").

8.1.3.10 Network Submenu: Pause, Continue, Step commands

Use these commands to control the progress in a post-processing network. Once a post-process begins, hitting the pause button will pause the playback. When a post-process is paused, it can either be continued using the continue button or you can step through the data one epoch at a time using the step button . These controls are similar to controls on a CD player.

Shortcuts:

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8.1.4 Tools Submenu commands

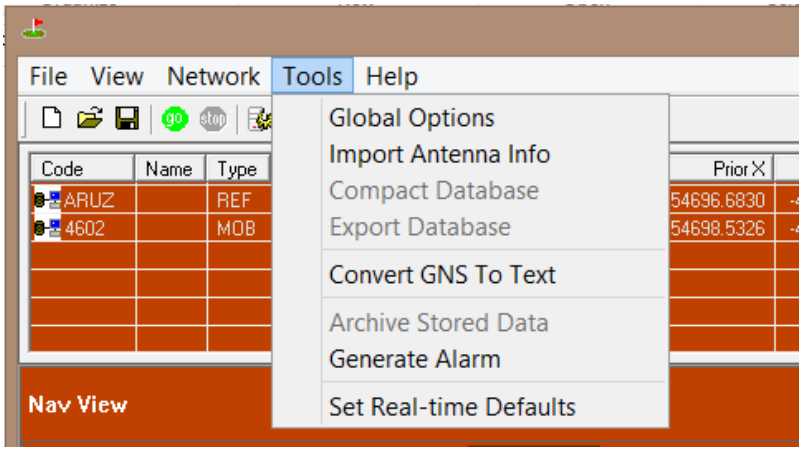

Figure 68 – Drop-down Tools Submenu

The Tools submenu offers the following commands:

Menu Command	Function
Global Options	Access GeoRTD global settings.
Import Antenna Info	Import antenna types information file into GeoRTD.
Compact Database	Compress the statistics database for live networks.
Convert GNS to Text	Convert a binary GNS file into text format.
Archive Stored Data	Initiate copying of downloaded data to archive.
Generate Alarm	Generate an alarm for testing purposes, such as checking the setup for sending alarms messages via email.
License Products	Access product licensing for GeoRTD.

Table 18 – Tools Submenu

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8.1.4.1 Tools Submenu: Global Options command

Use this command to access the GeoRTD Global Settings dialog. Reference the section on GeoRTD Global Settings for detailed information.

8.1.4.2 Tools Submenu: Import Antenna Info command

Use this command to import antenna types information file into GeoRTD.

This will summon the Import Antenna Info dialog, which prompts the user to specify the file to import.

IGS Antenna Phase Center File

The International GPS Service (IGS) and the U.S. National Geodetic Service (NGS) compile files with (relative) phase center information for GPS antennas. There are two formats currently in use. GeoRTD can import any file that adheres to either format.

The IGS standard file (igs_01.pcv) is available via FTP at:
ftp://igscb.jpl.nasa.gov/igscb/station/general

Note: This file has the same format as the NGS file “ant_info.001”.

For more information on the IGS, see their web site at http://igscb.jpl.nasa.gov/

Relative Antenna Calibration File

The Geosciences Research Division of the National Geodetic Survey performs many of the antenna calibrations used by the IGS. The NGS standard relative antenna calibration file (ant_info.003) is available via HTTP at:
http://www.ngs.noaa.gov/ANTCAL/images/ant_info.html

The GeoRTD installation disk includes copies of both of the latest antenna calibration files mentioned above.

Once antenna information has been imported into GeoRTD, it resides with the global data for the GeoRTD application. Imported antenna types are available in the Antenna Information field on the General Site Properties dialog for a site.

IMPORTANT NOTE: When a file is imported into GeoRTD, the information in the file will replace any antenna information that may have been previously imported into GeoRTD.

8.1.4.3 Tools Submenu: Compact database

GeoRTD records statistics for all sites in a database. For live networks, this can become quite large. This option compacts the database to reduce its size.

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8.1.4.4 Tools Submenu: Convert GNS to Text command

Use this command to convert a GNS file or a group of GNS files to text in various formats. GNS files are binary to reduce size, so to view the contents they may either be graphically displayed by GeoRTD or converted to text format. This command will bring up the Convert GNS to Text dialog. Use this dialog to specify the GNS file to convert, and the name of a file where text output is to be written.

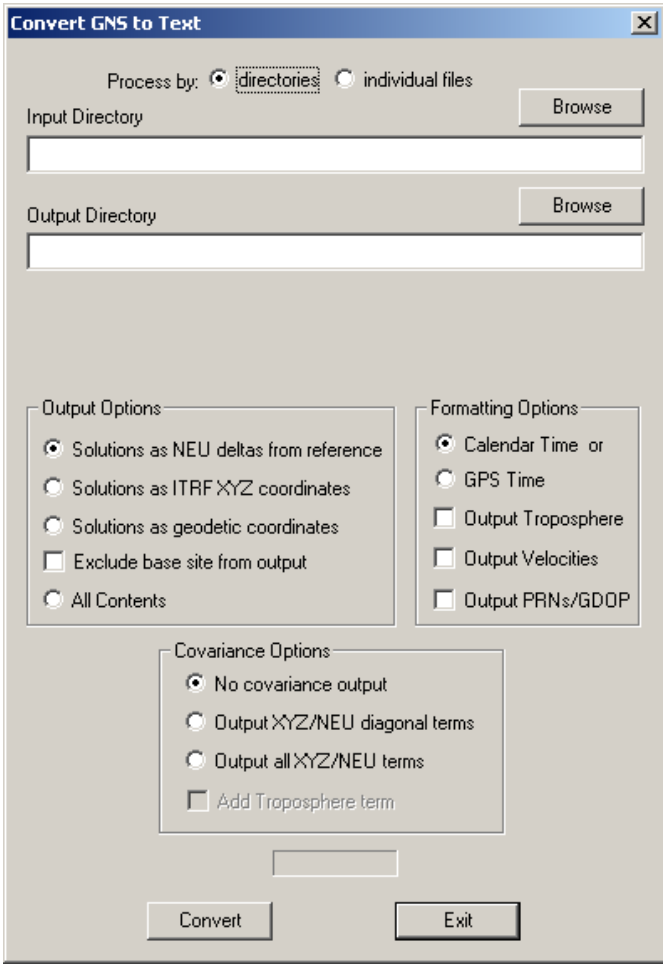

Figure 69 – Convert GNS to Text

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Field descriptions:

Process by Directories / Individual Files
Use this pair of radio buttons to choose whether you want to convert all of the gns files in a directory or just one specific file that you choose.

Input directory/file
Path to the GNS file or files to be converted.

Output directory/file
Path where converted text files are to be placed. All converted files will have the same name as the original except with a .txt file extension instead of a .gns extension. If you are converting an individual file, this field will be automatically populated with the input name with a .txt file extension and you have a chance to change the name if you desire.

Output Options Radio buttons
Defaults to "Solutions as NEU deltas from reference." This option provides North, East, Up baseline components relative to the reference (Master) site.

Select one of the other "Solutions as..." buttons if you wish the output file to contain the converted solution data in an absolute format: Cartesian (ITRF XYZ) or geodetic (Lat-Lon-Ht) site coordinates.

You can exclude the zero-values of the (fixed) reference site from output. For debug purposes, select "All Contents."

Formatting Options
If one of the "Solutions as..." output options is selected, this field allows you to configure the contents of the output file.

Select one of the time formats:

- "Calendar Time" will present solution times in Date (year/month/day) and Time (HH:MM:SS.S) format.
- "GPS Time" will present solution times in GPS week and second format.

Check the "Output Troposphere" box if you would like the estimated troposphere delay parameter to be included with each solution.

Check the "Output Velocities" box if you would like the site velocity components to be included with each solution.

Check the "Output PRNs/GDOP box if you would like the number of satellites used in the solution and the Geometric Dilution of Precision to be included with each solution.

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Covariance Options

For GNS files that contain covariance information for the estimated parameters (station position and/or troposphere delay parameters), the user can output the covariance values in two formats (other than "no covariance output" which is the default): (1) "Output XYZ/NEU diagonal terms" where the square roots of the diagonal elements of the covariance matrix (the parameter standard deviations) are output. These are followed by the square root of the chi-squared (goodness of fit) parameter. The output diagonal elements are not scaled by the chi-squared value; (2) "Output all XYZ/NEU terms" where the lower diagonal elements of the covariance matrix are output in the following order, (covXX, covXY, covYY, covXZ, covYZ, covZZ). These are followed by the chi-squared (goodness of fit) parameter. The covariance matrix is not scaled by the chi-squared value. The XYZ or NEU values will be output depending on the chosen output option. If the "Add troposphere box" is chosen, the corresponding troposphere (T) values will also be output. For example, for option 2 and with NEU output, the elements for each site are output in the following order, (covNN, covNE, covEE, covNU, covEU, covUU, covNT, covET, covUT, covTT, chi-squared).

Convert

Once the GNS and output files have been specified and desired options selected, press the Convert button to perform the conversion.

GNS Text Conversion Output

Geodetic Network Solution files (GNS) may be converted to text in various formats. Conversion is done via the menu item **Tools > Convert GNS To Text**. There will be a single line of text per epoch per site, with fields from left to right as follows:

- The site code. If NEU delta positions are to be output, the reference site will also be listed here. The reference site for NEU delta output will always be the first site in the network.
- The epoch time. This time may either be in GPS week/second format or date/time format as specified by the user.
- The position. The position may be delta NEU from the first site in the network, ITRF XYZ, or geodetics coordinates (latitude, longitude, height) as specified by the user. If XYZ is the selected position output type, the solution type will be output after position. This is of the form (TYP/FREQ). TYP is solution type, NON for non-solutions, ABS for absolute code, REL for relative code, and PHS for phase + code. FREQ denotes whether only L1 data was used or both L1 and L2 data.
- Troposphere, if selected.
- Velocity, if selected. Velocity is three fields, the rate of position change between the prior and current epoch in the north, east, and up axes.
- Covariance if and as selected. Available output combinations are 1) the X, Y, Z diagonal values only, 2) the X, Y, Z, and T diagonal values, 3) all X, Y, Z terms, and 4) all X, Y, Z, T terms. The scale factor is always as a final field if any covariance is selected.

The exception to the above is the "All contents" text conversion option. This option will convert all fields in all messages in the GNS file.

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8.1.4.5 Tools Submenu: Archive Stored Data command

Use this command to manually initiate the archival of RINEX, binary, and GNS files for the network. This command manually starts the same archival process that may be scheduled daily via the “Network Configuration/Manage Files” property page.

8.1.4.6 Tools Submenu: Generate Alarm command

Use this command to generate an alarm for testing purposes.

GeoRTD will immediately generate an alarm that will appear on the Alarm List window as a user-generated alarm. This test alarm will also be e-mailed to any of the addresses specified and enabled on the “Network Configuration/Alarms” property page.

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8.1.4.7 Help Submenu commands

The Help submenu offers the following commands, which provides assistance with GeoRTD:

Help Topics	Access GeoRTD's on-line help.
About GeoRTD	Indicates Copyright information, GeoRTD version, GeoRTD options, maximum number of network sites per configuration, license expiration date, simultaneous instances of GeoRTD (number of GeoRTD configurations that can be executed simultaneously), runs remaining, and security key code.

Table 19 – Help Menu

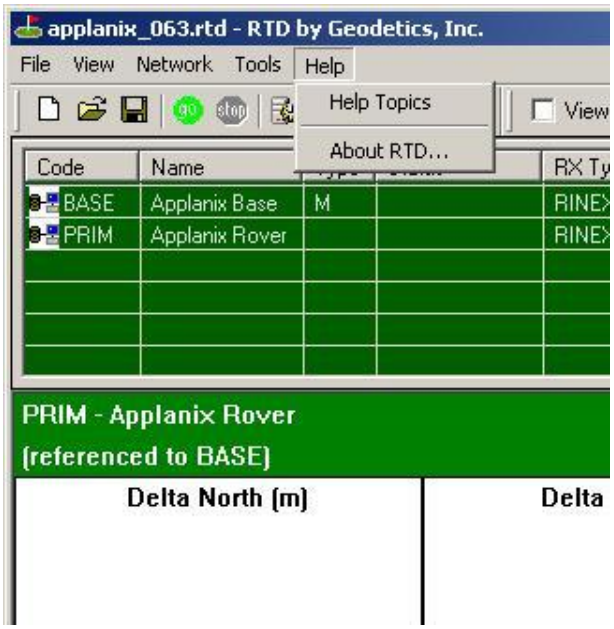

Figure 70 – Drop-down Help Menu

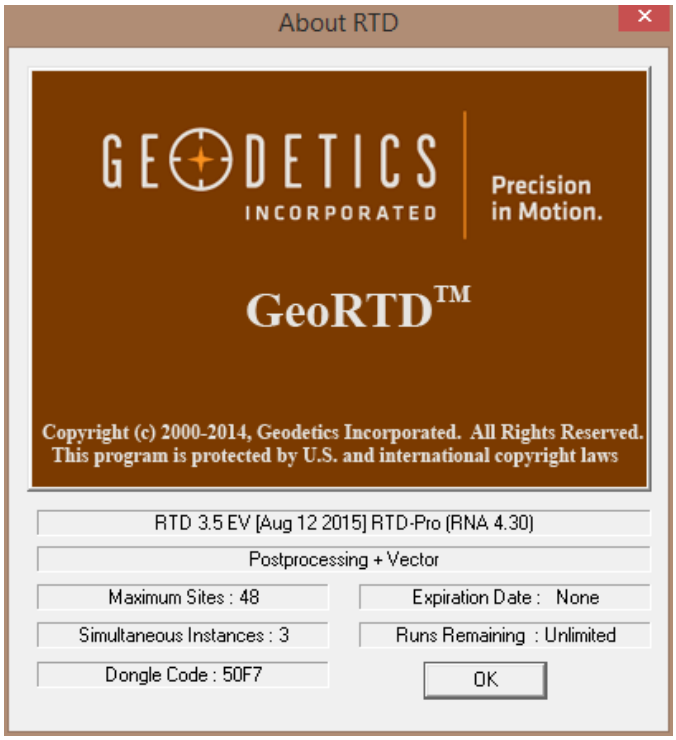

Figure 71 – Help: About GeoRTD

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8.2 GeoRTD Site Window Popup Menu Commands

Right-click on a network site in the Site Window to access this menu. It provides commands that can be performed on the selected site:

Site Properties	Access the Site Properties dialog to set a number of site-specific parameters.
Receiver Configuration	Access the Receiver Configuration property sheet to perform interactive configuration and monitoring of a receiver. Currently only available for the Leica RS500 series and Trimble SSI/SSE receivers.
Set As Master	Set the selected site as the Master (fixed) Site for the current network.
Change Comm Link	Change the communications link type to a receiver (Serial, TCP/IP or UDP).
Retrieve Data	Control whether data are retrieved from a site.
Process Data	Control whether data retrieved from a site are used in the network solution.
Move Up/Down	Move the site up or down one position in the site list.
Delete	Delete (remove) the selected site from the current network.

Table 20 – RTD Site Window Popup Menu

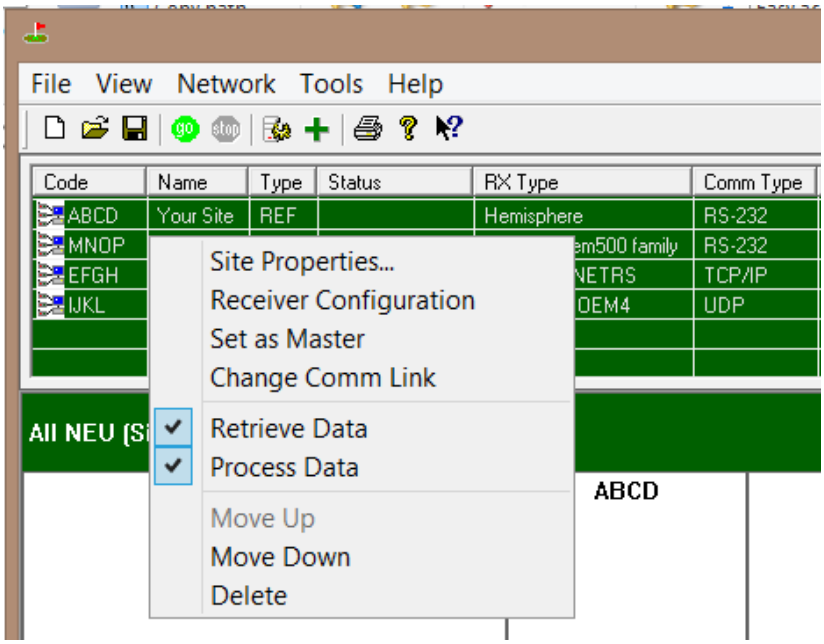

Figure 72 – Site Menu

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8.2.1 Site Properties Popup Menu Item

This menu item invokes the site properties window for a site, which allows the user to set a number of site-specific parameters. See the section on the GeoRTD Site Properties for complete details.

8.2.2 Receiver Configuration Popup Menu Item

This menu item invokes the receiver configuration window for the site, which allows the user to interactively configure and monitor the receiver. This feature is currently only available for Leica RS500 series receivers and Trimble 4000 SSI/SSE receivers. See the section on GeoRTD Receiver Configuration for complete details.

8.2.3 Set as Master Popup Menu Item

This menu item will set the selected site as the Master (fixed) Site for the current network. The order of sites will be re-arranged automatically so that the Master Site will always appear first in the list of network sites. After changing the Master Site, the user should check the settings for the parameters to be fixed/estimated at the new Master Site as well as at the site that was replaced as Master. When making a switch, the constraints and parameterization are also switched.

Background: One site in the network must be designated as the Master Site, or reference site. In general, the Master Site should have its coordinates fixed, serving as an absolute base receiver although this is not a requirement. The Master Site is not fixed when it and other network sites are in motion, and only relative positions are estimated.

8.2.4 Change Comm Link Popup Menu Item

This option is used if the communication link to a receiver needs to be changed, for example if a modem connection is being updated with some kind of direct RS-232 serial connection like a radio modem. You will be queried for the type of the new communication link (direct serial connection, modem connection, or TCP/IP network connection), and then the property tab for the new connection will appear and may be modified in the properties for the site.

8.2.5 Retrieve Data Popup Menu Item

Use this command to control whether data are retrieved (downloaded or streamed) from a site. The default value is data retrieval on. This command is useful when it is known that a site is temporarily not operational and needs to be excluded from data retrieval.

8.2.6 Process Data Popup Menu Item

Use this command to control whether data from a site are used in the processing of the network solution. The default value is processing on. Turning off processing for all sites is an effective option to test data communications just after installation of a new network.

8.2.7 Move Up/Down Popup Menu Item

Use this command to move the selected site up or down one position in the site listing.

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8.2.8 Delete Popup Menu Item

Use this command to delete a site from the current network.

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9.0 GeoRTD Receiver Configuration

GeoRTD receiver configuration invokes windows through which the receiver can be interactively configured and monitored. The configuration windows are accessed by right-clicking on a site in the GeoRTD Site Window and selecting “Receiver Configuration” on the site popup menu. This feature is not available for all receivers supported by GeoRTD. Currently only the Leica RS500 series of receivers and Trimble 4000SSI/SSE receivers are supported.

9.1 Leica RS500 Receiver Configuration

Configuration of the Leica RS500 is provided via a set of property pages, which are described in detail in the following sections. The communication link specified in the GeoRTD site properties is used to connect to and communicate with the receiver.

If the network is not running, the receiver will be connected to immediately via the defined communication link.

If the network is running and is a Real-time mode network, the receiver will be deactivated in the network and then reconnected for receiver configuration. The rest of the receivers in the network will continue to operate as before, but data will not be collected from the receiver you are configuring. When configuration of the selected receiver is complete, it will be added again to ongoing network processing automatically.

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9.1.1 RS500 General Settings

The RS500 Configuration “General Settings” page is used to display and configure the site position coordinates, the satellite elevation cutoff angle, and the Doppler option for broadcast data in the RS500 receiver. The RS500 may also be reset (by cycling power) from this page.

When the page is initially displayed, the RS500 is queried for current settings that are then displayed in the editable fields in black text. The user may then edit these settings (except as noted). If a field has been modified from the current receiver state the field will change to red text. Clicking on the “Send to Sensor” button will update the RS500 with the current values in all of the fields on the page. Clicking the “Refresh” button will cancel any pending changes and query the sensor for its current settings again.

Associated site information as entered in the current GeoRTD network is displayed above the appropriate fields. This information is for user reference only and cannot be changed on this page.

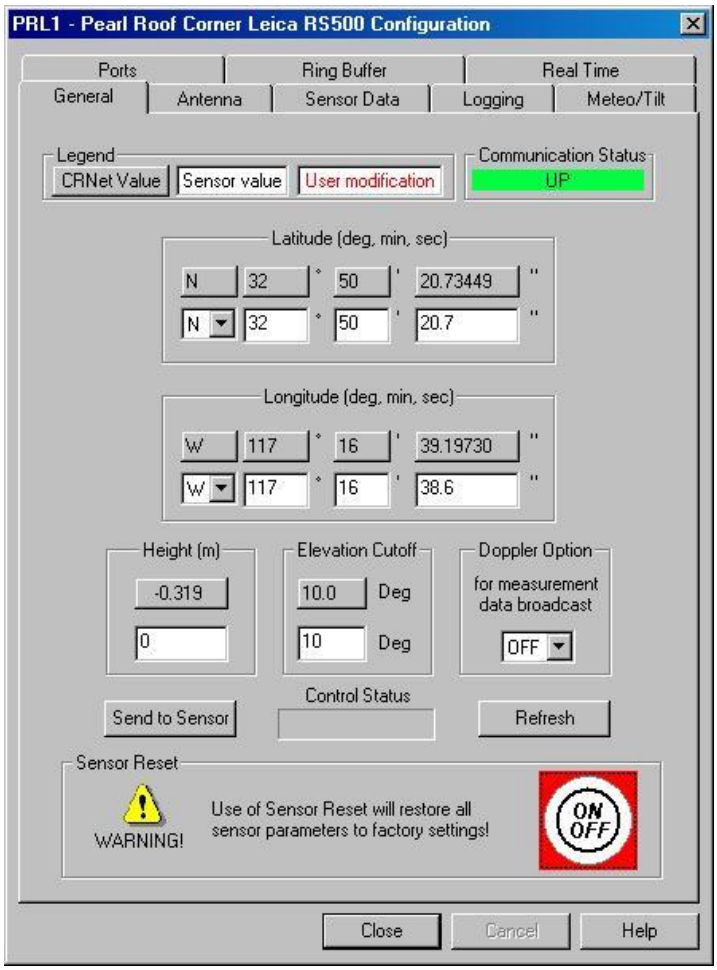

Figure 73 – Leica RS500 Configuration: General

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The data on the page is only updated when the page is initially displayed, the “Refresh” button is clicked, or “Send to Sensor” button is clicked. The communication status indicates the success of the most recent attempt to query the receiver for the displayed fields; it will be either “UP” (i.e. “ok”) with a green background or “DOWN” with a red background, indicating a failure.

Field descriptions:

Latitude, Longitude, Height
The site geodetic coordinates for the receiver. Height is in meters.

Elevation Cutoff
Also known as the minimum tracking elevation angle. Units are in degrees. The sensor will not track satellites below this elevation angle. The read-only network value reflects the setting on the **Network Configuration: Processing** property page.

The RS500 only accepts this parameter in half-degree increments. User entered values will be rounded to the nearest half degree.

Doppler Option
Set this to option ON to have the sensor include Doppler values with broadcast observation data.

Note: this option does not affect internal logging. To set the Doppler option for internal logging, see **RS500 Logging Configuration**.

Sensor Reset
This will cycle power on the RS500, which will restore all of the sensor parameters to the factory settings. This process takes some time, and the application will wait until it can query the sensor before completing the reset operation.

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9.1.2 RS500 Antenna Settings

The RS500 Configuration “Antenna” page is used to examine and configure the antenna information in the receiver.

When the page is initially displayed, the RS500 is queried for current settings that are then displayed in the editable fields in black text. The user may then edit these settings (except as noted). If a field has been modified from the current receiver state the field will change to red text. Clicking on the “Send to Sensor” button will update the RS500 with the current values in all of the fields on the page. Clicking the “Refresh” button will cancel any pending changes and query the sensor for its current settings again.

Associated site information as entered in the current GeoRTD network is displayed above the appropriate fields. This information is for user reference only and cannot be changed on this page.

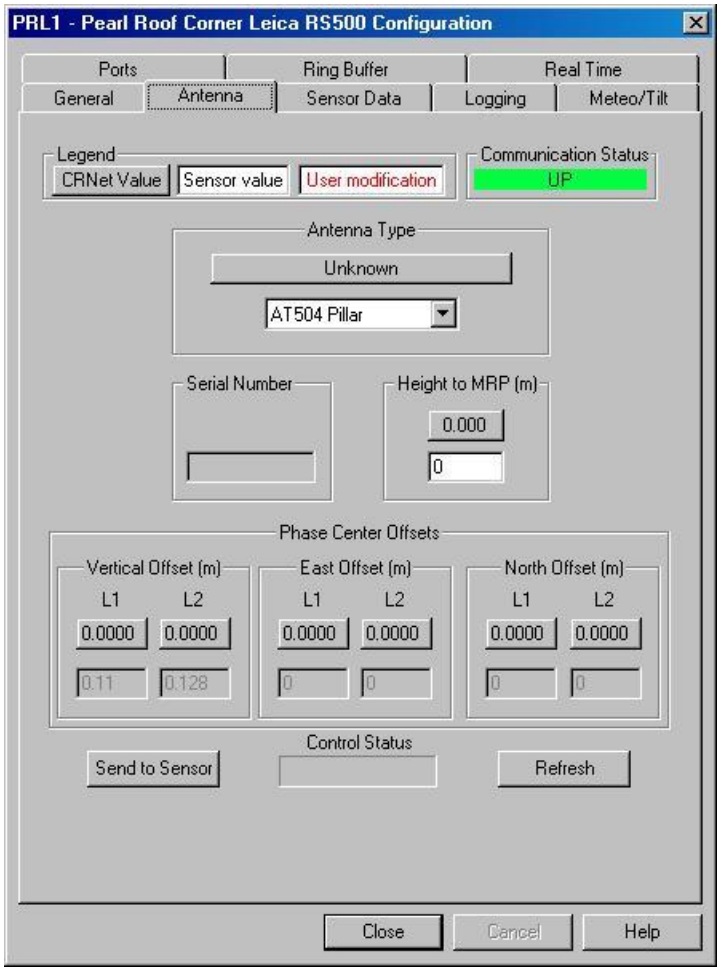

Figure 74 – Leica RS500 Configuration: Antenna

The data on the page is only updated when the page is initially displayed, the “Refresh” button is clicked, or “Send to Sensor” button is clicked. The communication status indicates the success of the most recent attempt to query the receiver for the displayed fields; it will be either “UP” (i.e. “ok”) with a green background or “DOWN” with a red background, indicating a failure.

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Field descriptions:

Antenna Type

Use this field to display or set the antenna type in the RS500. If the antenna type received from the RS500 is not one of the types available in the dropdown list, this field will display “Unknown”. User may select an antenna from the list of available types, or “Unknown”. When an antenna type is selected, the data for that antenna are loaded into the phase center offsets fields. If “Unknown” is selected, then the user may edit the phase center offsets fields.

Serial Number

This field displays the serial number (if any) received from the sensor. This field is display only.

Height to MRP

Use this field to display or set the vertical height from the marker (site location) to the MRP (Measurement Reference Point) on the antenna (in meters). This field does not support sloped antenna height measurement.

Phase Center Offsets

This field displays the L1 and L2 phase center offset values that will be sent or were received from the sensor. If user selects an antenna type of “Unknown”, then these fields may be edited.

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9.1.3 RS500 Logging Configuration

The RS500 Configuration “Logging” page is used to examine and change the receiver’s internal logging settings. Memory utilization of the sensor’s PC Card, current logging rate, current job name, current file prefix and Doppler option for internal logging are displayed.

This page also provides for the management and downloading of the log files, and the option of reformatting the PC card on the RS500.

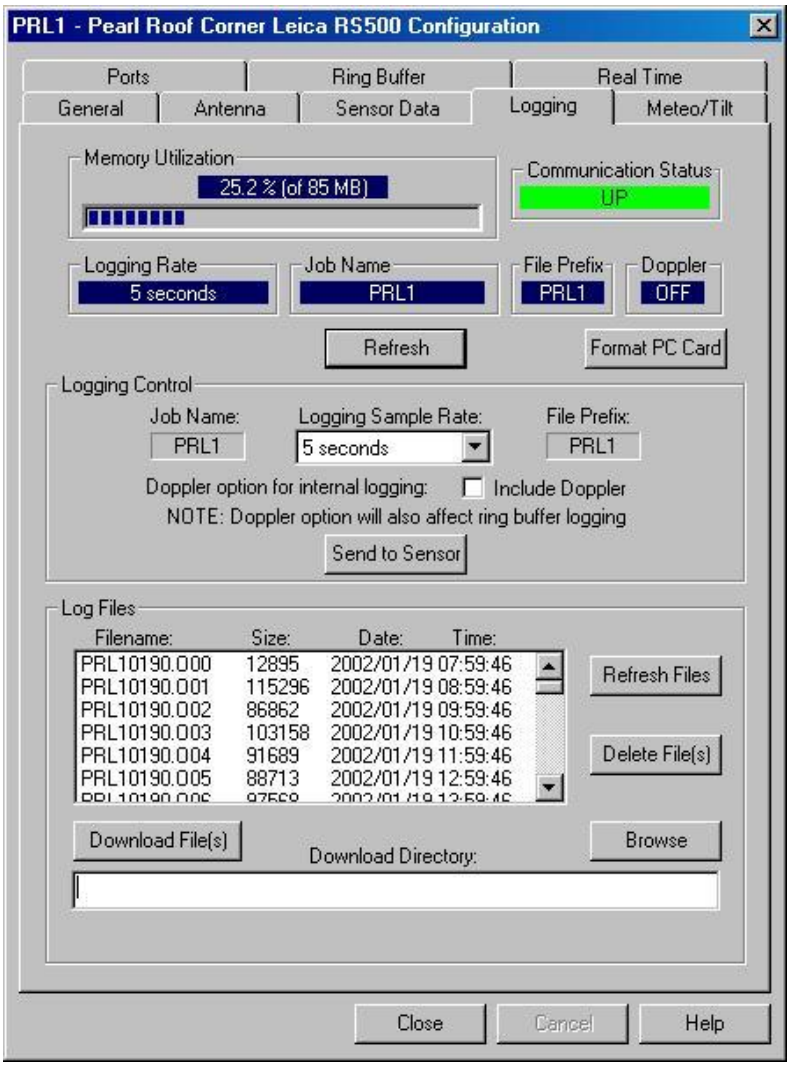

Figure 75 – Leica RS500 Configuration: Logging

The data on the page is only updated when the page is initially displayed, the “Refresh” button is clicked, or “Send to Sensor” button is clicked. The communication status indicates the success of the most recent attempt to query the receiver for the displayed fields; it will be either “UP” (i.e. “ok”) with a green background or “DOWN” with a red background, indicating a failure.

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Static Logging Control

The logging control section is used to disable or enable internal logging on the RS500 at a specified rate. The Doppler option for internal logging can also set in this section. The job name and file prefix will be the site ID as entered in the current GeoRTD network. The sample rate is user specifiable. The "Send to Sensor" button sends a command to the receiver to configure internal logging as well as set the Doppler option per the user selected values. Results will be displayed in the read-only fields in the upper part of the page.

Notes on the Doppler option:

1.) *The Doppler option controls whether Doppler information is added to both the primary internal logging, on this page, and ring buffer logging (see* ***RS500 Ring Buffer Configuration****).*

2.) This Doppler option does not affect whether Doppler information is added to the measurement data broadcast by the receiver. To set the Doppler option for broadcast data, see ***RS500 General Settings****.*

Log Files

The log files section is used to display and manage log files on the sensor's PC card. Use the "Refresh Files" button to query the sensor and update the file list display. A single file or multiple files may be selected from the file list display. Use the "Delete File(s)" button to remove (erase) the selected file(s) from the sensor PC card. Use the "Download File(s)" button to download the selected file(s) from the sensor. Use the "Download Directory" to specify where the downloaded files should be stored (this must be specified before files can be downloaded). Click the "Browse" button to use an explorer window to find and specify the path for the download directory.

Note: You may delete or download log files while logging is active.

Format PC Card

Use the "Format PC Card" button to clear the contents of the PC Card on the sensor. The PC Card is where the log files and ring buffer files are stored on the sensor.

Note: Use care when using the "Format PC Card" option. All files (including the log files and ring buffer files) stored on the card will be erased once this command is completed.

Note: Performing "Format PC Card" must turn off any active Logging or Ring Buffer logging. Restart these functions (if desired) after the Format PC Card operation is completed.

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9.1.4 RS500 Sensor Data Display

The RS500 “Sensor Data” display page is a display-only window of various data from the receiver. The data is updated approximately every 2 seconds. The communication status will be either “UP” with a green background or “DOWN” with a red background, indicating the success of the most recent attempt to query the receiver for the displayed fields. Displayed fields are site ID, current date and time, calculated position (latitude, longitude, and height), firmware version, external sensor voltage, elevation cutoff mask, DOP values (PDOP, GDOP, HDOP, VDOP), and channel tracking status.

The channel tracking status shows information about satellites currently visible and tracked. It may be displayed in either a tabular or graphical format, which is toggled by pushing or releasing the button labeled “Tabular”. The tabular view has more information such as channel numbers assigned and signal to noise quality, the graphical view makes it easier to visualize satellite position currently observed by the receiver. For details on how to interpret the graphical presentation, please refer to ***Screen Graphics: PRN Track.***

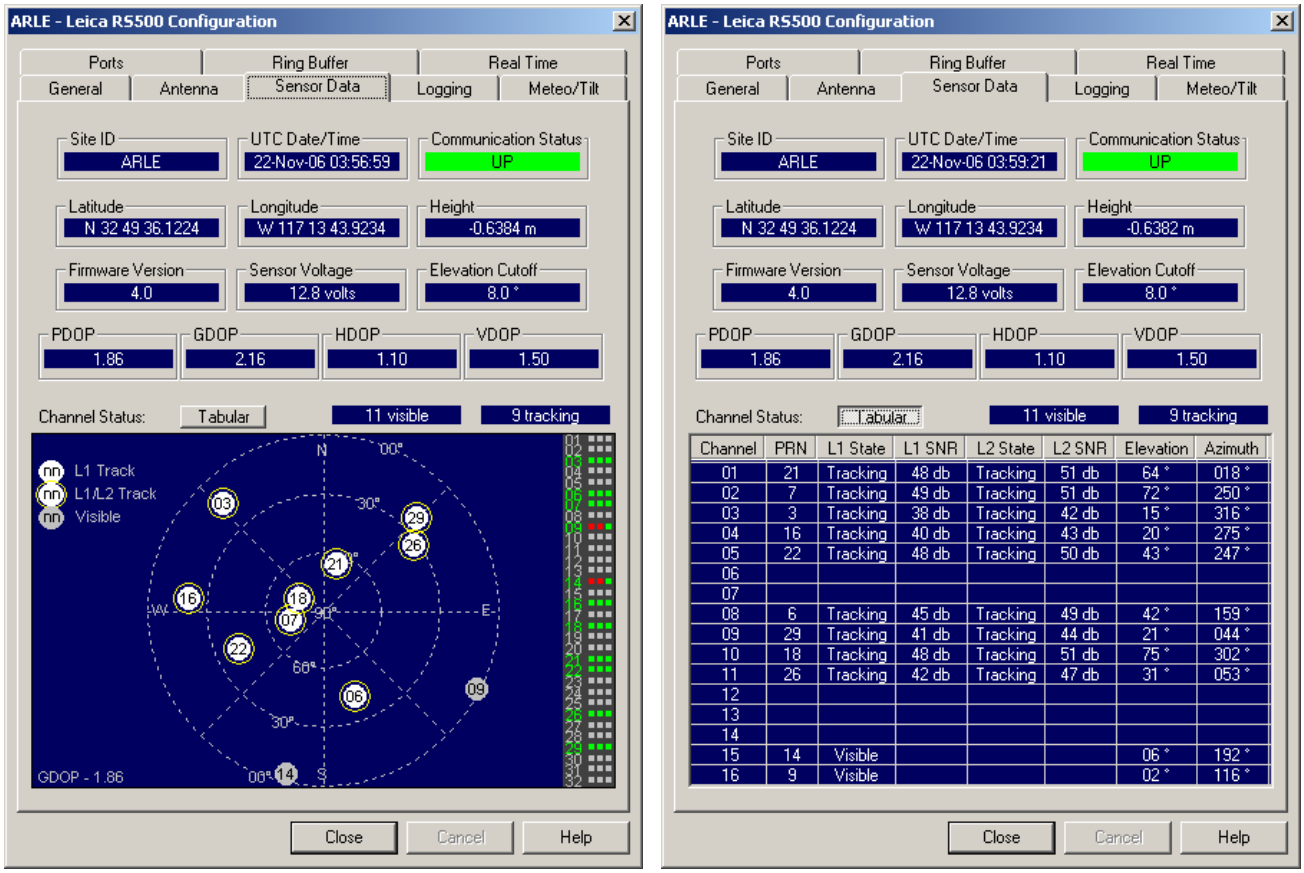

Figure 76 – Leica RS500 Configuration: Sensor Data

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9.1.5 RS500 Meteorological and Tilt Sensor Configuration (Meteo/Tilt)

The RS500 Configuration “Meteo/Tilt” page is used to examine and change meteorological and tilt sensor settings in the receiver (if these sensors are attached). Current configuration Status, current Input Rate, and current sensor Type and Port assignment are displayed.

The data on the page is only updated when the page is initially displayed, the “Refresh” button is clicked, or “Send to Sensor” button is clicked. The communication status indicates the success of the most recent attempt to query the receiver for the displayed fields; it will be either “UP” (i.e. “ok”) with a green background or “DOWN” with a red background, indicating a failure.

The configuration control sections are used to enable and configure the collection of meteorological and tilt data on the RS500, and to indicate whether these data will be logged internally. The “Send to Sensor” button in each section will send the selected configuration settings from that section to the receiver. If communication with the receiver is successful, these settings will then be reflected in the display at the top of the page.

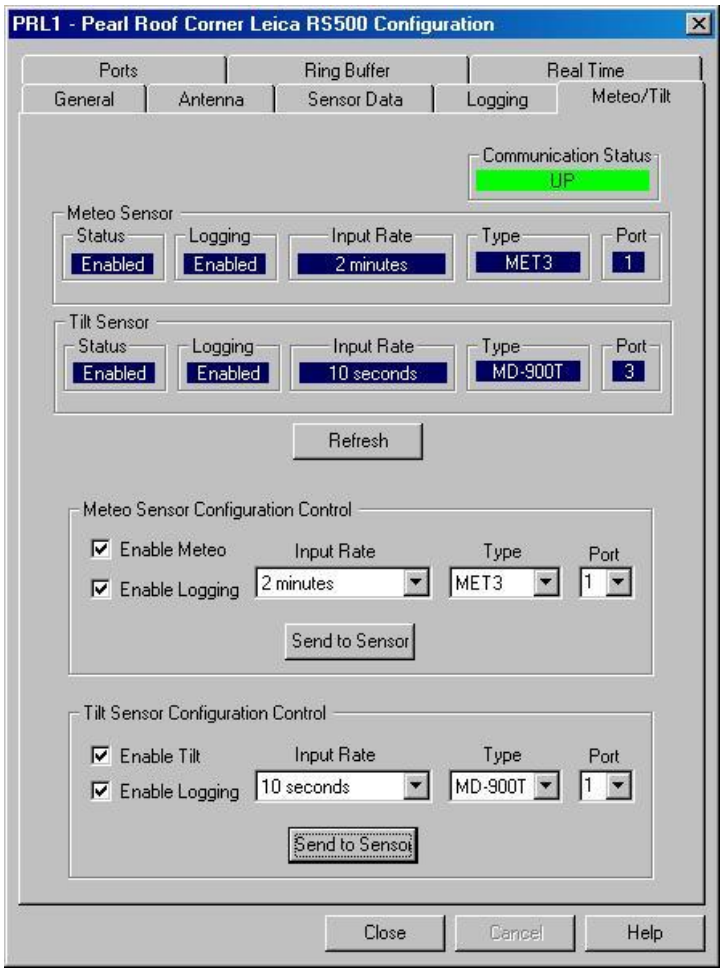

Figure 77 – Leica RS500 Configuration: Metro/Tilt

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Field descriptions:

Meteo Sensor Configuration Control

Enable Meteo
Check this box to direct the receiver to collect data from the meteorological sensor. This data will then be available to a Real-time GeoRTD network and will appear in any Raw Receiver Data files or RINEX files that are created as the network runs.

Enable Logging
Check this box to direct the receiver to store data collected from the meteorological sensor internally (Meteo must also be enabled for data to be logged). The meteorological data will be logged with the other data as indicated on the **RS500 Logging Configuration** page.

Related Topic: See **Store Files** property page for information on creating Raw Receiver Data or RINEX files.

Input Rate
Select the interval at which you would like the RS500 to collect data from the meteorological sensor.

Port
Select the port on the RS500 that the meteorological sensor is connected to. Only ports 1-3 that are not already assigned to another device (tilt sensor, remote control, or real-time broadcast) will be available.

Type
Indicate which type of meteorological sensor is connected to the RS500.

Tilt Sensor Configuration Control

Enable Tilt
Check this box to direct the receiver to collect data from the tilt sensor. This data will then be available to a Real-time GeoRTD network and will appear in any Raw Receiver Data files or RINEX files that are created as the network runs.

Enable Logging
Check this box to direct the receiver to store data collected from the tilt sensor internally (Tilt must also be enabled for data to be logged). The tilt data will be logged with the other data as indicated on the **RS500 Logging Configuration** page.

Logging must be enabled to make the tilt data available to a Periodic/manual Download GeoRTD network. This data will appear in any Raw Receiver Data files or RINEX files that are created as the network runs.

Related Topic: See **Store Files** property page for information on creating Raw Receiver Data or RINEX files.

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Input Rate
Select the interval at which you would like the RS500 to collect data from the tilt sensor.

Port
Select the port on the RS500 that the tilt sensor is connected to. Only ports 1-3 that are not already assigned to another device (met sensor, remote control, or real-time broadcast) will be available.

Type
Indicate which type of tilt sensor is connected to the RS500.

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9.1.6 RS500 Ports Configuration

The RS500 Configuration “Ports” page is used to examine and change the baud rates for the serial ports on the RS500. The current devices allocated to each port and the port over which GeoRTD is communicating with the RS500 are also displayed.

The data on this page is updated whenever the page is accessed, when the “Refresh” button is clicked, or when the “Send to Sensor” button is clicked. The communication status will be either “UP” with a green background or “DOWN” with a red background. It indicates the success of the most recent attempt to query the receiver for the displayed fields.

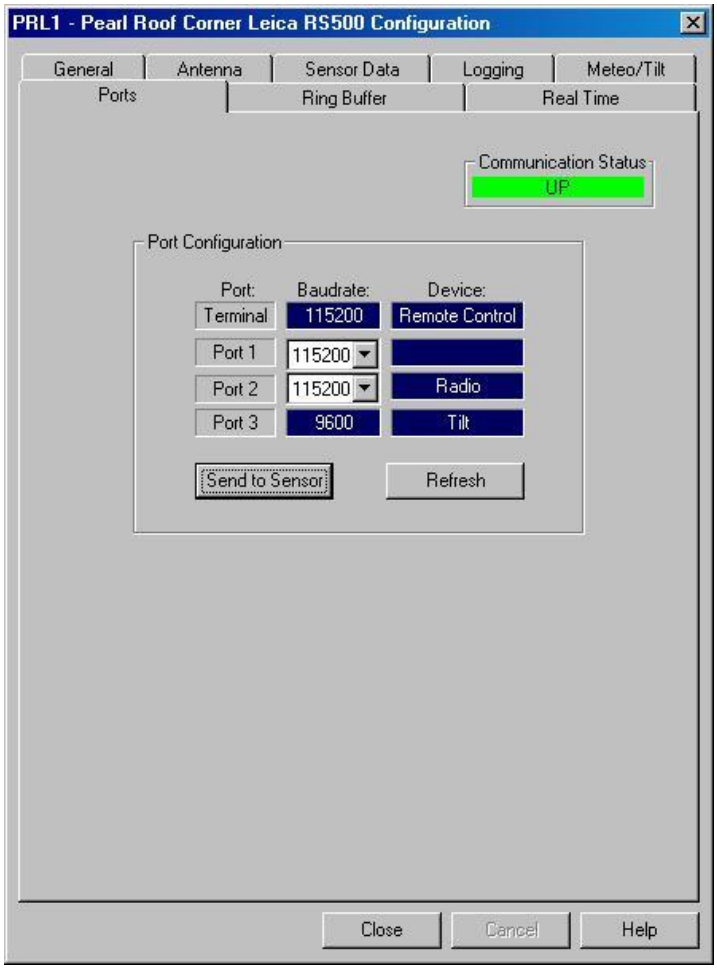

Figure 78 – Leica RS500 Configuration: Ports

The port configuration section can be used to configure the baud rate for serial ports 1-3 on the RS500. The baud rate of the terminal port cannot be modified. The baud rate on the port that GeoRTD is currently attached to (labeled “Remote Control”) cannot be modified.

Other port configuration parameters are fixed at the following standard settings:

Parity: None
Data Bits: 8
Stop Bits: 1

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Field descriptions:

Baudrate
Select the baud rate for the port. When the baud rate for a port cannot be changed, this list is replaced with a static display of the current baud rate for that port.

Device (display only)
This field lists the device that is assigned to a port:

Meteo	Meteorological sensor is assigned to this port
Tilt	Tilt sensor is assigned to this port
Radio	A real-time broadcast device is assigned to this port
Remote Control	GeoRTD is communicating over this port
Terminal	This is the terminal port

If the device field is blank, then the port is not currently assigned to any device.

Control descriptions:

Send To Sensor
Click this button to send baud rate modifications to the sensor.

Refresh
Click this button to query the sensor for current baud rates and port assignments.

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9.1.7 RS500 Ring Buffer Configuration

The RS500 Configuration “Ring Buffer” page is used to configure and control ring buffer logging. This page also provides for management and downloading of ring buffer files.

Ring buffer logging is also known as secondary internal logging. This type of logging consists of a set of files that span the specified buffer duration. The RS500 will log data to each of these files in turn, looping back to write over the first file when they are all filled.

The data on the page is only updated when the page is initially displayed, or the “Refresh”, “Send to Sensor”, or “Refresh Files” button is clicked. The communication status indicates the success of the most recent attempt to query the receiver for the displayed fields; it will be either “UP” with a green background or “DOWN” with a red background.

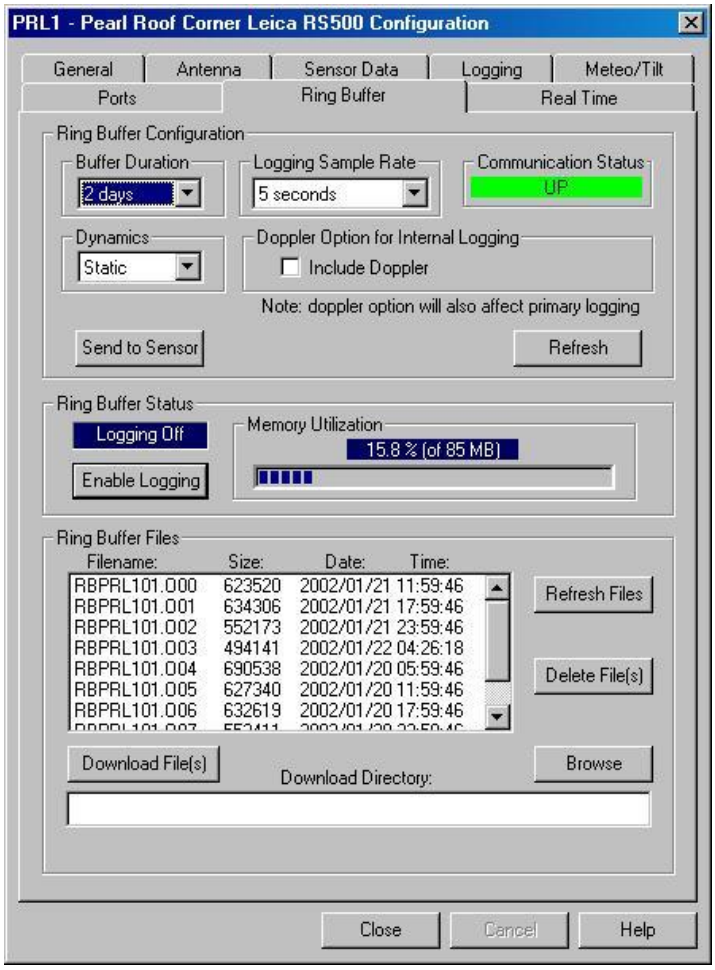

Figure 79 – Leica RS500 Configuration: Ring Buffer

This page is divided into three sections:

The ***Ring Buffer Configuration*** section at the top is used to configure the ring buffer and to set the Doppler option for internal logging. The ring buffer configuration cannot be modified while the ring buffer is active (enabled) or while previously created ring buffer files still exist on the sensor.

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The ***Ring Buffer Status*** section in the middle of the page is used to enable or disable ring buffer logging, and to display the current status and memory utilization.

The ***Ring Buffer Files*** section at the bottom is used to display and manage the files in the ring buffer.

Field descriptions:

Ring Buffer Configuration

Buffer Duration
Select the duration for the ring buffer. Duration defines the minimum timespan of data that will be collected before looping back to the beginning of the ring buffer.

Logging Sample Rate
Select the rate at which data should be collected into the ring buffer.

Dynamics
Indicate Static or Kinematic.

Doppler Option for Internal Logging
Select this option to have Doppler information added to both primary internal logging and ring buffer logging.

*Note: The Doppler option setting cannot be modified if primary logging (see the **RS500 Logging Configuration** page) is currently enabled.*

*Note: This option does not affect whether Doppler information is added to measurement data broadcast by the receiver. To set the Doppler option for broadcast data , see **RS500 General Settings**.*

Send To Sensor
Click this button to update the sensor with the selected ring buffer and Doppler option configuration settings.

Refresh
Click this button to query the sensor for the current ring buffer configuration and status.

<u>Ring Buffer Status</u>

Status Window
This window indicates whether ring buffer logging is enabled (“logging on”) or disabled (“logging off”).

Memory Utilization
Display represents percentage of internal memory used in the RS500.

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Enable/Disable Logging
Click this button to enable or disable Ring Buffer logging on the RS500.

Ring Buffer Files

Files Window
This window presents a list of the ring buffer files on the RS500. Files can be selected here for download from the sensor or for deletion (multiple files or blocks of files can be selected).

Download Directory
Use this field to specify the directory path where the downloaded ring buffer files should be stored. Click the **Browse** button to use an explorer window to find and specify the path.

Refresh Files
Click this button to query the sensor and update the directory of files.

Note: updating the directory usually takes several seconds.

Delete File(s)
Click this button to delete one or more ring buffer files selected from the file list.

Note: ring buffer files can be deleted while the ring buffer is active, but the file currently being logged to will not be deleted.

Download File(s)
Click this button to download one or more ring buffer files selected from the file list. The Download directory must be specified before files can be downloaded.

Note: ring buffer files can be downloaded while the ring buffer is active.

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9.1.8 RS500 Real-Time Configuration

The RS500 Configuration “Real-time” page is used to examine and configure real-time (RTK) input or output configurations on the RS500 (or related receivers).

For RTK output (broadcast), up to two radio devices are available. One input channel is available for RTK input (Rover mode). Available RTK message formats include Leica, Trimble CMR, and several RTCM formats.

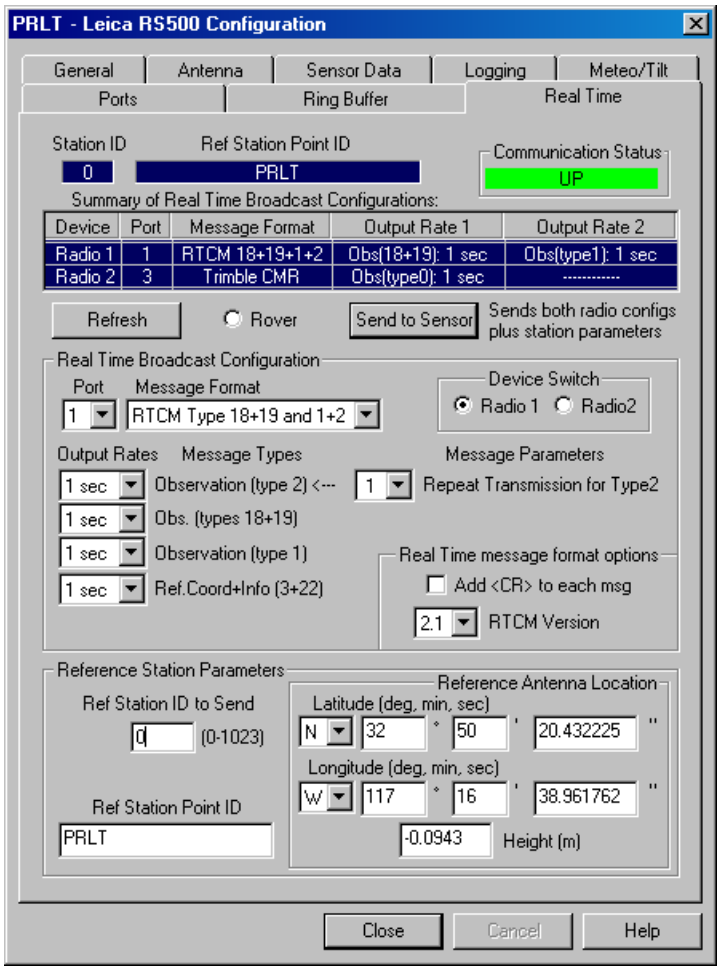

Figure 80 – Leica RS500 Configuration: Real-time

The fields with the dark background color in the upper portion of the page provide the highlights of the active real-time configuration(s) (if any) in the receiver. The current station ID and point ID are displayed above a table summarizing the configuration of the RTK device(s). This table shows the Port assignment, Message Format (or “disabled”), and the Output Rate of the one or two most significant message types in the format.

The rest of the page is used to display and edit all of the information required to define the RTK configurations. This part of the page changes format, depending on whether the receiver is being configured for RTK input (Rover mode) or for RTK output (broadcast). This choice is controlled by the ***Rover*** switch: The default is set to configure RTK output. Select the rover switch “ON” to configure the receiver to accept RTK input.

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NOTE: The Rover option will only be made available if the receiver can support RTK input. If this is not supported, the Rover switch is inactive and only RTK output configurations will be available.

The following sections describe the details of the real-time configuration fields, which depend on the Rover switch selection:

The data on the page is only updated when the page is initially displayed, the “Refresh” button is clicked, or “Send to Sensor” button is clicked. The communication status indicates the success of the most recent attempt to query the receiver for the displayed fields; it will be either “UP” (i.e. “ok”) with a green background or “DOWN” with a red background, indicating a failure.

9.1.8.1 Real-Time configuration fields for RTK output (broadcast mode)

This is the default option and is always available. Refer to above figure for illustration of the page in this mode. RTK output allows for 1 or 2 output configurations, or “Radio devices”.

The “***Refresh***” button is used to query the receiver and update all of the fields to reflect the current settings in the RS500. If real-time devices are active, the configuration information is loaded into the configuration fields and is available for inspection or modification. Use the ***Device Switch*** to control which radio device is currently displayed in the Real-time broadcast configuration fields. The Reference Station Parameter fields will also be loaded with current settings from the receiver.

The “***Send to Sensor***” button is used to send the current configuration settings (including any user modifications) for **both** devices (Radio 1 and Radio 2) as well as the Reference Station Parameters to the RS500. To review current configuration settings before sending them to the RS500, use the ***Device Switch*** to toggle between the devices.

The ***Real-time Broadcast Configuration*** section is used to specify and configure the message formats for up to two real-time broadcast devices. The first device is referred to as “Radio 1” and the second is referred to as “Radio 2”. The ***Device Switch*** indicates which real-time device is being displayed/edited and is used to switch between the two devices.

The ***Reference Station Parameters*** section provides information about the reference station that will be applied to both real-time devices. The station point ID and antenna location fields will default to the Site ID and site position from GeoRTD but can be modified by the user if desired.

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Field descriptions:

Real-time Broadcast Configuration

Device Switch
Select which real-time device you would like to view/edit. All of the other fields in this section refer to the device that is selected here.

Port
Select the port assignment for the real-time device. Only ports 1-3 that are not already assigned to another device (tilt or met sensor, remote control, or the other radio device) will be available.

Baud rate for the port can be configured on the **RS500 Ports Configuration** page.

Message Format
Select the message format to be broadcast on this device, or “Disabled” to disable real-time broadcast for this device. Format options include Leica, Trimble CMR, and many different RTCM combinations.

As each message format is made up of different mixtures of message types, selecting a given message format will change the number and description of the following message type/output rate and message parameter fields.

Output Rates / Message Types
Each message format is made up of a number of different messages, identified by message type. Select the desired output rate for each of the listed message types for the selected message format.

Message Parameters
Certain message types require additional parameters beyond output rate. Use these fields (when applicable) to specify the indicated parameter. These fields will only displayed if information is needed.

Add CR
Check this box if you want a carriage return (<CR>) added to the end of each broadcast message.

RTCM Version
For RTCM message formats only, select the RTCM version to use for this broadcast device.

Reference Station Parameters

Ref Station ID
Select the Station ID (1-32) that will be broadcast from both radio devices. The default ID is 1.

Ref Station Point ID

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Enter the Point ID string that will be broadcast from both radio devices. If no real-time devices are currently configured in the receiver, this field is initialized to match the Site ID from GeoRTD. An entry in this field can be up to 16 characters long but should not include the following invalid characters: $ * , ! \ ^ ~ ?

Reference Antenna Location
Specify the coordinates of the reference antenna that will be broadcast from both radio devices. If no real-time devices are currently configured in the receiver, these fields will be initialized to match the Site position from GeoRTD.

***Warning**: For proper operation in real-time broadcast mode, take special care to submit a reference antenna location that closely matches the actual antenna location. After successful configuration for real-time broadcast, this location will be used by the RS500 to acquire and track satellites. Submitting a grossly erroneous position can cause erratic sensor behavior.*

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9.1.8.2 Real-Time configuration fields for RTK input (rover mode)

This section describes the configuration fields for RTK input, or “rover” mode, which is accessed by selecting the Rover switch “ON”. Refer to the figure below for illustration of the page in this mode.

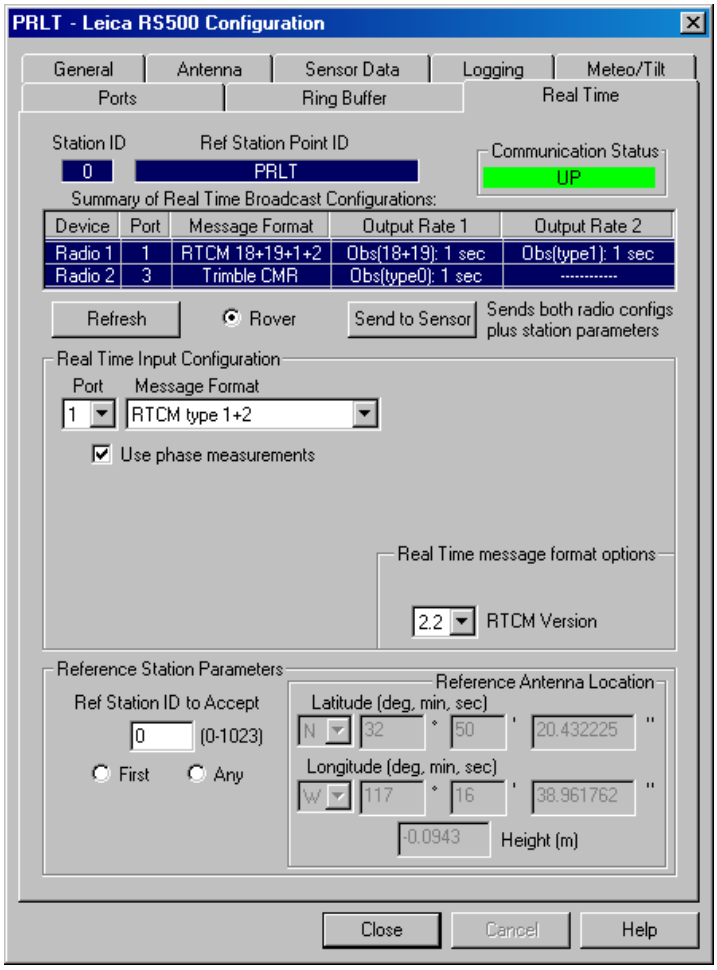

Figure 81 – Leica RS500 Configuration: Real-time RTK input (Rover) Mode

The “***Refresh***” button is used to query the receiver and update all of the fields to reflect the current settings in the RS500. If a real-time input device is active, the configuration information is loaded into the configuration fields and is available for inspection or modification. The Reference Station Parameter fields will also be loaded with current settings from the receiver.

The “***Send to Sensor***” button is used to send the current configuration settings (including any user modifications) as well as the Reference Station Parameters to the RS500.

The ***Real-time Input Configuration*** section is used to specify and configure the message format that receiver should expect as input.

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The ***Reference Station Parameters*** section allows the user to control which reference stations the receiver will accept input from

Field descriptions:

Real-time Broadcast Configuration

Port
Select the port assignment for real-time input. Only ports 1-3 that are not already assigned to another device (tilt or met sensor, or remote control) will be available.

Baud rate for the port can be configured on the **RS500 Ports Configuration** page.

Message Format
Select the message format to expect, or “Disabled” to disable real-time input. Format options include Leica, Trimble CMR, and many different RTCM combinations.

Use Phase Measurements
Check this box if the receiver should use the phase measurements received on the input device.

RTCM Version
For RTCM message formats only, select the RTCM version to expect on the input device.

Reference Station Parameters

Ref Station ID
Use this field to control which reference station the receiver should accept input from. There are three different options:

(1) Type in the Station ID (0-1023) of the reference station,
(2) Select the **First** button to have the receiver accept the first station it receives messages from.
(3) Select the **Any** button to have the receiver accept input from any station.

Reference Antenna Location
These fields will be visible but disabled for RTK input. The values only apply for RTK output.

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9.2 Trimble 4000SSI/SSE Receiver Configuration

Configuration of the Trimble 4000SSi is provided via a graphical representation of the front panel of the receiver. The current contents of the LCD display on the receiver are presented in this interface. User selections are made by clicking the applicable “buttons” in this interface.

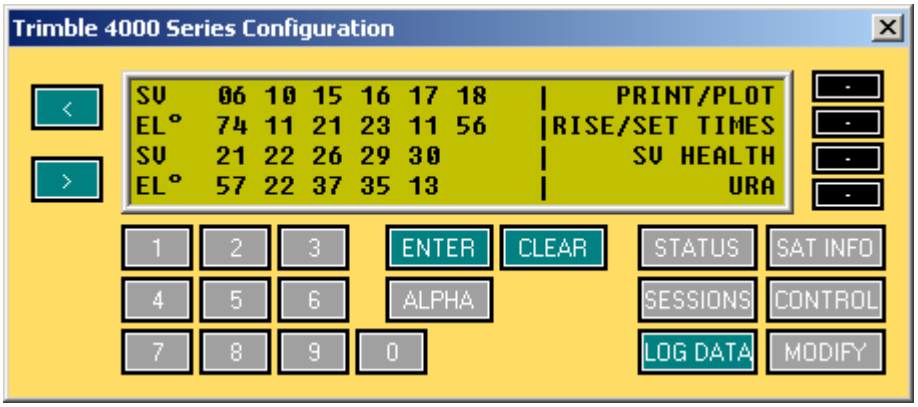

Figure 82 – Trimble 4000SSi Receiver

The operation of this interface is identical to using the front panel on the receiver (see the User’s Manual for the Trimble 4000SSi for details).

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10.0 Appendix A: Configuring Equipment for Use with GeoRTD

10.1 Before you begin

We assume that you have already installed GeoRTD on a host computer system using the "Installation Instructions" described earlier, and that the security key has been connected to the computer's USB or parallel port, or installed in the file system. The computer system must meet or exceed the specifications given under system requirements. We further assume that the computer is connected to one or more GPS receivers either by an RS-232 cable (a direct connect), another communication arrangement that implements an RS-232-like link over a greater distance (e.g. short haul modems, or radio modems), a modem used with a dedicated telephone line, via a TCP/IP network, or some combination of these devices. The communication links between GeoRTD and the GPS receivers are discussed in greater detail below.

We assume that one or more sites have been physically set up in locations where the GPS antenna has a clear view of the sky and multipath or radio frequency interference are not serious problems. It is recommended that no other physical object should be located within 2 meters of a GPS antenna at or above the level of the antenna. Ideally there will no obstructions at elevation angles higher than 15 degrees (as viewed from the antenna) at *any* distance from the antenna. The user is now ready to set up GeoRTD to collect data from the sites and to solve for their geometry on a continuous basis. It will be possible to add additional sites as and when they are constructed.

10.2 Configuring Leica Receivers

Each receiver must be configured for use with GeoRTD with control software provided by Leica. GeoRTD needs to collect three types of data from each receiver:

- Ephemeris data
- Dual-frequency phase and pseudorange (code) observations
- Meteorological/auxiliary data (optional)

Each of the two supported Leica receiver families has a different Leica software configuration application. For CRS1000 receivers the application is a DOS program named MC-CDU. For RS500 series receivers the application is a Windows program named Control Station. For either, there are 2 general configuration steps that need to be performed with the Leica configuration software:

- Set the baud rate at which the receiver will send and receive data.
- The port settings in GeoRTD (for a direct RS232 connection) or the communication device to which the receiver is attached will have to match the configured baud rate of the connected receivers for successful communication.
- Setup internal logging (CRS1000s only).

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- For CRS1000's via MC-CDU, this is done from the "Internal Logging Ctrl" page. The messages required to be logged are LB2 88 messages (ephemeris) at a rate of "when avail", LB2 10 messages (meteorological/auxiliary data) at a rate of "when avail", and LB2 03 messages (observation data) at the desired sample interval (e.g. every 5 seconds). The CRS1000 should be set up to do 24-hour rolls.

- For RS500 series receivers, GeoRTD will automatically configure the receiver internal logging with the sample rate you specify in the receiver properties.

For either receiver / configuration-software pair, please refer to the documentation provided with the software. These programs can interact with the receivers in a great many ways, and accordingly it is essential that the user consult the user guides for specific details

Note that there is a relationship between the number of sites in a network, the speed of the data transfers between GeoRTD and the sites, and the maximum sample rate that should be programmed into the receiver. The maximum viable sample rate will usually depend on the available speed of data communications. A 5 second rate is a reasonable sample rate unless the network is a large one or the data communications are unusually slow.

Next it is necessary to provide a communications link between GeoRTD and each receiver. At present GeoRTD supports three communication modes:

- **RS-232 connections.** A serial port on the receiver will be connected to a serial port on the base computer running GeoRTD either by an RS-232 cable, if the receiver is located near the base computer, or via any device which transparently extends the range of an RS-232 connection. This includes spread-spectrum radio modems and short-haul modems. Follow the vendor's instructions on how to set up these devices. Use of such modems will be undetectable to GeoRTD and the receivers - for all intents and purposes these communication devices may be thought of as very long RS-232 cables. In all cases the RS-232 connection at the CRS1000 end is made into serial Port A on the receiver.

- **Modem/telephone line connections.** Use only those types of modems that are currently supported by Leica. Follow Leica's instructions for connecting the modem, and configuring the receiver for use with the modem via its appropriate Leica configuration software application. Make a note of the modem settings for use with GeoRTD.

- **TCP/IP Sockets.** The receiver will be paired with a device such as a network modem or terminal server that is capable of communicating with the receiver on its RS-232 interface and making that interface available over a TCP/IP network. GeoRTD will communicate with such a device over the network through the network interface card installed on the PC. Follow the vendor's instructions on how to assign and IP address and port to the network modem or terminal server, and how to set the baud rate to match that of the receiver.

It is the user's responsibility to assure that the way in which GeoRTD is programmed to collect data is logically consistent with the number of available communication channels.

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10.3 Modem Setup for the RS500 Family of Receivers

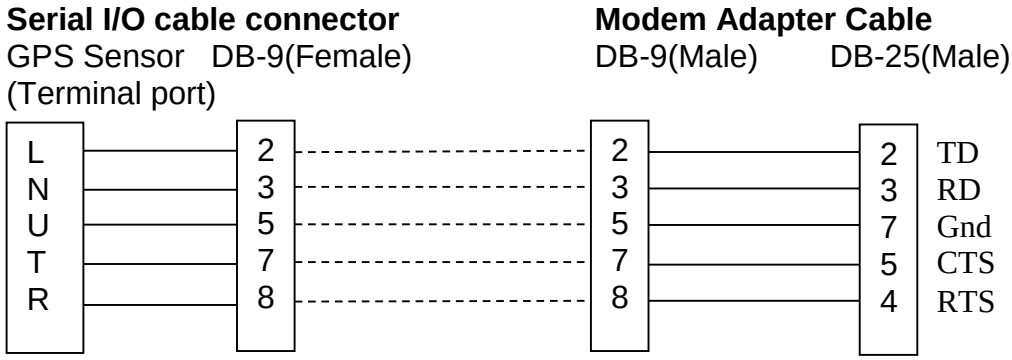
10.3.1 Introduction

This section describes how to configure a **3Com/USRobtics Faxmodem** to work with the System500 GPS sensor. When connecting a modem to any generic scientific sensor not designed specifically to connect to a modem several issues must be addressed.

The key issues involved in communicating, via modem, between a System500 GPS sensor and a PC running the GeoRTD program are:

1) The GPS sensor and PC communicate using Leica Binary (LB2) messages. The modem must be connected to Terminal port.

2) Both the System 500 and the modem are configured like a DCE (Data Communications Equipment) device. Both are expecting to be connected to a DTE (Data Terminal Equipment) device such as a computer. Thus when connecting a GPS sensor to a modem the TD/RD and RTS/CTS pens must be reversed. This can be down using a null modem adapter and DB-9 to DB-25 adapter cable, both of which can be purchased from any computer store or by building an adapter cable as shown below.



3) The modem normally expects to use data terminal ready signal (DTR) to enable data flow. Since the GPS sensor does not support the DTR signal, the modem must be configured to forced DTR true (i.e. override DTR).

4) Whenever the modem receives a command (AT message) from the PC it automatically adjusts the baud rate of the serial port to match the PC. Since the GPS sensor never sends an ASCII “AT” command to the modem, its serial port baud rate must be fixed to the required value prior to connecting it to the GPS sensor. The default setting for most modems allows the serial port baud rate to change depending on the connection speed. For use with the System500 GPS sensor this feature must be disabled and the serial port baud rate fixed to match the GPS sensor port setting.

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5) To insure that the data are transmitted error free the modems must be configured to connect only with error correction protocol enabled. This feature allows the receiving modem to request that the sending modem retransmit any data packet that is received in error.

6) Most modems will not answer the phone while receiving data. This feature allows the mode to check if the incoming data is a command changing the modem configuration. Since the incoming data could be a command to disable auto-answer, the modem first processes the incoming data before answering the phone. If the modem is constantly receiving data it will never answer the phone. This problem can be resolved by insuring no messages are scheduled for output by the GPS sensor on the modem port. This problem can also be resolved by using a modem that has an external switch to disable command mode. This setting is also called dumb mode or transparent mode on some modems.

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10.3.2 Reference Site Modem Setup

The 3Com/USRobtics Faxmodem can be set to work with the System500 GPS sensor by following the steps listed below:

1) Set the baud rate of System500 GPS sensor.

2) Set the switches as shown below <u>except set switch 7 & 8 **down** until step 8</u>.

1	2	3	4	5	6	7	8
Down	Up	Down	Up	Up	Up	Up	Up

Switch #	**Description**
1	Data terminal ready (DTR) override
2	Verbal result codes
3	Display result codes
4	Echo offline commands
5	Auto answer on first ring
6	Carrier detect normal
7	Load NVRAM defaults at power-up
8	Dumb mode (Note: Switch 8 must be set up for operation, but down for programming)

3) Connect the modem to Com1 of the computer using a standard DB25 to DB9 (or DB25 to DB25) modem cable.

4) Using Windows 95/98 via Start / Programs / Accessories execute the program Hyperterminal.

5) When the “New Connection” window opens press “Cancel”.

6) Via File / Properties click the Connect tab and select “Com1”, then press the “Configure” button and set the fields as shown:

   - Baud rate = Same as Reference Site GPS sensor’s.
   - Data Bits = 8
   - Parity = none
   - Stop Bits = 1
   - Flow control = None

7) Type AT(enter), the modem should respond with “OK”

8) Type AT&F0&B1&M5&N0&Y0&W0, the modem should respond with “OK”. This sets up the modem configuration as follows:

   - &F0 = Set to factory default settings <u>without</u> hardware flow control
   - &B1 = Fix serial port speed to the current baud rate
   - &M5 = Force ARQ (error correcting) connection
   - &N0 = Variable connect speed
   - &Y0 = Load VRAM(0) configuration at power up
   - &W0 = write current settings (configuration) to VRAM(0)

9) Type ATI4 to output the modem configuration and verify that the baud rate and other settings are correct.

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10) Power off modem, disconnect from PC and **set switches 7 & 8 up**.

11) Connect the modem to the GPS sensor using the custom interface cable described previously.

Note: The custom cable connects pin 2 to 2 and 3 to 3 because the standard pin assignments for pins 2 & 3 are reversed between a DB9 and DB25 connector as shown in the following tables. The RTS and CTS lines are not reversed as expected because of the nonstandard pin assignments used by the MC/CRS1000 interface cable.

Pin	Description	Signal	Direction to/from DTE device
1	Carrier detect	CD	In
2	Receive data	RD	In
3	Transmit data	TD	Out
4	Data terminal ready	DTR	Out
5	Signal ground	GND	-
6	Data set ready	DSR	In
7	Request to send	RTS	Out
8	Clear to send	CTS	In
9	Ring indicator	RI	in

Table 21 – RS-232 DB9 Connector

Pin	Description	Signal	Direction to/from DTE device
1	Chassis Ground	-	-
2	Transmit data	TD	Out
3	Receive data	RD	In
4	Request to send	RTS	Out
5	Clear to send	CTS	In
6	Data set ready	DSR	In
7	Signal ground	GND	-
8	Carrier detect	CD	In
9	(+) Xmit current loop return	-	Out
11	(-) Xmit current loop data	-	Out
18	(+) Rcv current loop data	-	In
20	Data terminal ready	DTR	Out
22	Ring indicator	RI	In
25	(-) Rcv current loop return	-	In

Table 22 – RS-232 DB25 Connector

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10.3.3 PC Modem Setup

The 3Com/USRobtics Faxmodem can be set to work with a PC running the ControlStation software by following the steps listed below:

1. Set the switches as shown below except set switch 7 down until step 9.

1	2	3	4	5	6	7	8
Up	Up	Down	Up	Down	Up	Up	Down

Switch #	**Description**
1	Data terminal ready (DTR) normal
2	Verbal result codes
3	Display result codes
4	Echo offline commands
5	Auto answer off
6	Carrier detect normal
7	Load NVRAM defaults at power-up
8	Smart mode

2. Connect the modem to Com1 of the computer using a standard DB25 to DB9 (or DB25 to DB25) modem cable.
3. Using Windows 95/98 via Start / Programs / Accessories execute the program Hyperterminal.
4. When the “New Connection” window opens press “Cancel”.
5. Via File / Properties click the Connect tab and select “Com1”. Then press the Configure button and set the fields as shown:
   - Baud Rate = Any rates
   - Data Bits = 8
   - Parity = none
   - Stop Bits = 1
   - Flow control = None
6. Type AT(enter), the modem should respond with “OK”.
7. Type AT&F0&B1&M5&N0&Y0&W0, the modem should respond with “OK”. This commands set up the modem as follows:
   - &F0 = Set to factory default settings <u>without</u> hardware flow control
   - &B1 = Fix serial port speed
   - &M5 = Force ARQ (error correcting) connection
   - &N0 = Variable connect speed
   - &Y0 = Load VRAM(0) configuration at power up
   - &W0 = Write current settings (configuration) to VRAM(0)
8. Type ATI4 to output the modem configuration and verify that the baud rate and other settings are correct.
9. The modem is now ready for use by a PC running the ControlStation software.
10. Power off modem, and **<u>set switch 7 up</u>**.

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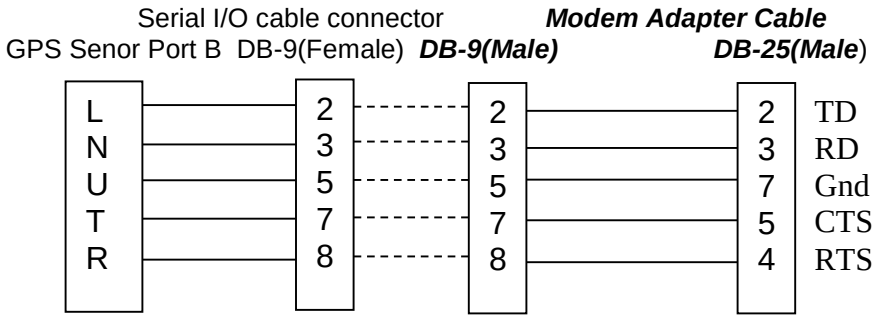
10.4 Modem Setup for the CRS1000 Family of Receivers

10.4.1 Introduction

This section describes how to configure a **3Com/USRobtics Faxmodem** to work with the MC/CRS1000 GPS sensor. When connecting a modem to any generic scientific sensor not designed specifically to connect to a modem several issues must be addressed.

The key issues involved in communicating, via modem, between a MC1000 or CRS1000 GPS sensor and a PC running the CDU program are:

1) The GPS sensor and PC communicate using Leica Binary (LB2) messages. Binary data prohibits the use of software (Xon/Xoff) handshaking, hardware handshaking (CTS/RTS) must be used to ensure that the data are not output faster than it can be transmitted by the modem. Only Ports B & D of the MC/CRS1000 GPS sensor support hardware handshaking. Thus, the modem must be connected to either port B or D and hardware handshaking (or pacing) enabled in both the GPS sensor and the modem.
2) Both the MC/CRS 1000 and the modem are configured like a DCE (Data Communications Equipment) device. Both are expecting to be connected to a DTE (Data Terminal Equipment) device such as a computer. Thus when connecting a the GPS sensor to a modem the TD/RD and RTS/CTS pens must be reversed. This can be down using a null modem adapter and DB-9 to DB-25 adapter cable, both of which can be purchased from any computer store or by building an adapter cable as shown below.



3) The modem normally expects to use data terminal ready signal (DTR) to enable data flow. Since the GPS sensor does not support the DTR signal, the modem must be configured to forced DTR true (i.e. override DTR).
4) Whenever the modem receives a command (AT message) from the PC it automatically adjusts the baud rate of the serial port to match the PC. Since the GPS sensor never sends an ASCII “AT” command to the modem, the modem serial port baud rate must be fixed to the required value prior to connecting it to the GPS sensor. The default setting for most modems allows the serial port baud rate to change depending on the connection speed. For use with the MC/CRS1000 GPS sensor this feature must be disabled and the serial port baud rate fixed to match the GPS sensor port setting.
5) To insure that the data are transmitted error free the modems must be configured to connect only with error correction protocol enabled. This feature allows the receiving modem to request that the sending modem retransmit any data packet that is received in error.

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6) Most modems will not answer the phone while receiving data. This feature allows the mode to check if the incoming data is a command changing the modem configuration. Since the incoming data could be a command to disable auto-answer, the modem first processes the incoming data before answering the phone. If the modem is constantly receiving data it will never answer the phone. This problem can be resolved by insuring no messages are scheduled for output by the GPS sensor on the modem port. This problem can also be resolved by using a modem that has an external switch to disable command mode. This setting is also called dumb mode or transparent mode on some modems.

Connecting the modem to port B or D has the added advantage of making port A available for local control of the GPS sensor. The receiver can also be controlled from port B or D, but the status displays will not updated as no messages will be scheduled for output.

10.4.2 MC/CRS1000 GPS Sensor Setup

The default setting for port B disables handshaking. To enable hardware handshaking and configure port B for connection to a modem use the following setting in the Serial port Configuration screen:

```
┌──────────────────── Serial Port Configuration: Sensor 1 ────────────────────┐
   RS   Baud  Pacing Stp/Prty  Out Format  In Format   PCprt Cntrl |
Prt
 B  232   57K   CTS   1/None   LB2 Aux1    LB2 Aux1                  |
```

When dumping internal data be sure to set the output port on the dump screen to port B or D prior to initiating the dump, as shown below.

```
+--------------------- Internal LB2 Data Logging Control -------+
¦+------------------------ File Control -----------------------+¦
¦¦ Fn Fsize Stat P Repeat StGeoRTDate StrtTime StopDate StopTime¦¦
¦¦ 0  497 Stop B 1 Hrs 06/04/99 19:20:55 06/04/99 19:23:46¦¦
¦¦ 1   1 Stop A 0 None 06/04/99 21:17:08 06/04/99 21:21:39¦¦
```


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10.4.3 Reference Site Modem Setup

The 3Com/USRobtics Faxmodem can be set to work with the MC/CRS1000 GPS sensor by following the steps listed below:

1. Set the switches as shown below <u>except set switch 7 & 8 **down** until step 8</u>.

1	2	3	4	5	6	7	8
Down	Up	Down	Up	Up	Up	Up	Up

Switch #	**Description**
1	Data terminal ready (DTR) override
2	Verbal result codes
3	Display result codes
4	Echo offline commands
5	Auto answer on first ring
6	Carrier detect normal
7	Load NVRAM defaults at power-up
8	Dumb mode (Note: Switch 8 must be set up for operation, but down for programming)

2. Connect the modem to Com1 of the computer using the a standard DB25 to DB9 (or DB25 to DB25) modem cable.
3. Using Windows 95/98 via Start / Programs / Accessories execute the program Hyperterminal.
4. When the “New Connection” window opens press “Cancel”.
5. Via File / Properties click the Connect tab and select “Com1”, then press the “Configure” button and set the fields as shown:
   - Bits/ser = 57600
   - Data Bits = 8
   - Parity = none
   - Stop Bits = 1
   - Flow control = Hardware
6. Type AT(enter), the modem should respond with “OK”.
7. Type AT&F1&B1&M5&N0&Y0&W0, the modem should respond with “OK”. This commands set up the modem configuration as follows:
   - &F1 = Set to factory default settings <u>with</u> hardware flow control
   - &B1 = Fix serial port speed to the current baud rate
   - &M5 = Force ARQ (error correcting) connection
   - &N0 = Variable connect speed
   - &Y0 = Load VRAM(0) configuration at power up
   - &W0 = write current settings (configuration) to VRAM(0)
8. Type ATI4 to output the modem configuration and verify that the baud rate and other settings are correct.
9. Power off modem, disconnect from PC and **<u>set switches 7 & 8 up</u>**.
10. Use the CDU program to set the MC1000/CRS1000 GPS sensor port B or D to 57K baud.
11. Connect the modem to the GPS sensor using the custom interface cable described previously.

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Note: When using the custom cable to connect the modem the black 232/422 adapter labeled CBCA43859 does not need to be used.

Note: The custom cable connects pin 2 to 2 and 3 to 3 because the standard pin assignments for pins 2 & 3 are reversed between a DB9 and DB25 connector as shown in the following tables. The RTS and CTS lines are not reversed as expected because of the nonstandard pin assignments used by the MC/CRS1000 interface cable.

Pin	Description	Signal	Direction to/from DTE device
1	Carrier detect	CD	In
2	Receive data	RD	In
3	Transmit data	TD	Out
4	Data terminal ready	DTR	Out
5	Signal ground	GND	-
6	Data set ready	DSR	In
7	Request to send	RTS	Out
8	Clear to send	CTS	In
9	Ring indicator	RI	in

Table 23 – RS-232 DB9 Connector

Pin	Description	Signal	Direction to/from DTE device
1	Chassis Ground	-	-
2	Transmit data	TD	Out
3	Receive data	RD	In
4	Request to send	RTS	Out
5	Clear to send	CTS	In
6	Data set ready	DSR	In
7	Signal ground	GND	-
8	Carrier detect	CD	In
9	(+) Xmit current loop return	-	Out
11	(-) Xmit current loop data	-	Out
18	(+) Rcv current loop data	-	In
20	Data terminal ready	DTR	Out
22	Ring indicator	RI	In
25	(-) Rcv current loop return	-	In

Table 24 – RS-232 DB25 Connector

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10.4.4 PC Modem Setup

The 3Com/USRobtics Faxmodem can be set to work with a PC running the GPS control program (CDU) by following the steps listed below:

1. Set the switches as shown below except set switch 7 down until step 9.

1	2	3	4	5	6	7	8
Up	Up	Down	Up	Down	Up	Up	Down

Switch #	Description
1	Data terminal ready (DTR) normal
2	Verbal result codes
3	Display result codes
4	Echo offline commands
5	Auto answer off
6	Carrier detect normal
7	Load NVRAM defaults at power-up
8	Smart mode

2. Connect the modem to Com1 of the computer using the a standard DB25 to DB9 (or DB25 to DB25) modem cable.
3. Using Windows 95/98 via Start / Programs / Accessories execute the program Hyperterminal.
4. When the “New Connection” window opens press “Cancel”.
5. Via File / Properties click the Connect tab and select “Com1”, Then press the Configure button and set the fields as shown:
   - Bits/ser = 57600
   - Data Bits = 8
   - Parity = none
   - Stop Bits = 1
   - Flow control = hardware
6. Type AT(enter), the modem should respond with “OK”.
7. Type AT&F0&B1&M5&N0&Y0&W0, the modem should respond with “OK”. This commands set up the modem are as follows:
   - &F0 = Set to factory default settings <u>without</u> hardware flow control
   - &B1 = Fix serial port speed
   - &M5 = Force ARQ (error correcting) connection
   - &N0 = Variable connect speed
   - &Y0 = Load VRAM(0) configuration at power up
   - &W0 = Write current settings (configuration) to VRAM(0)
8. Type ATI4 to output the modem configuration and verify that the baud rate and other settings are correct.
9. The modem is now ready for use by a PC running the CDU program.
10. Power off modem, and **<u>set switch 7 up</u>**.

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Note: Although the serial port of the modem has been set to 57600 baud the connect speed may vary depending on line conditions.

10.4.5 Using the CDU Program to call the MC1000/CRS1000 GPS Sensor

Once the modems are properly configured and connected to the PC and MC1000/CRS1000 use the following steps to initiate a call from the PC to the GPS Sensor. It is not possible for the GPS sensor to call the PC.

1) Insure that the phone line is connected to the phone jack on the modem that is labeled “Line” or to the jack annotated with a wall sock icon.
2) Be sure that the modem is connected to the GPS Sensor using the black 232/422 adapter.
3) Start the CDU program
4) Select the PC Setup/Modem Control screen and set the “Pri LB2” field to Com1 and 57K.
5) Press F3 to invoke the Modem Control screen.
6) Enter ATDT (phone number) in the Dial String field.
7) Press the Dial Modem button.

Note: If the modems connect but the CDU does not detect the GPS Sensor the most likely cause is a baud rate mismatch. The incoming data can be viewed using the Primary LB2 Logging screen.

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11.0 Appendix B: Geo-Toolbox Utilities

The Geo-Toolbox Utilities have been moved to their own document. Please refer to Geo-Toolbox User Manual P/N 20141 a copy of which is on the CD shipping with each Geo-iNAV. Please contact Geodetics, Inc. for more information.

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12.0 Appendix C: Protocols and Formats

12.1 RYO Protocol

Basic information about the RYO Protocol is available in the Geo-iNAV User Manual P/N 20134 a copy of which is on the CD shipping with each Geo-iNAV. Please contact Geodetics, Inc. for more information.

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12.2 Ambiguity Log File

Ambiguity logging can be enabled on the Advanced tab of Network Configuration. Ambiguity information will be logged for each baseline pair at each epoch. Following is a sample output line with a description of the columns:

```
(2 - 1) 1240 433650.00 05 09 19667553 15242555 14 -20093194 -15640124 /
15 -23002 -83375 18 16473613 12783331 21 5788801 4402538 23 -9845942 -7714144 /
26 14606412 11297593 30 -16881255 -13188782
```

The first field “(2 - 1)” indicates site 2 - site 1

The second field “1240” is GPS week

The third field “433650.00” is GPS second of week

The fourth field “05” indicates PRN 05 is the base satellite

The remaining fields are triplets of PRN number x

- L1 ambiguity (relative to base satellite)
- L2 ambiguity (relative to base satellite)
- The first triplet from the sample output above, “09” indicates ambiguities are from PRN 09 relative to PRN 05, 19667553 is the L1 ambiguity, and 15242555 is the L2 ambiguity.

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13.0 Appendix D: Miscellaneous Notes

13.1 Automatic Start

It is possible to have GeoRTD automatically start when the PC workstation is rebooted such as when power is lost. To do this, there are two steps to follow:

1) Get Windows NT/2000/XP to log onto an account automatically, bypassing the login prompt.

This is done via registry settings under the key:

HKEY_LOCAL_MACHINE\Software\Microsoft\Windows NT\CurrentVersion\Winlogon

Set the DefaultDomainName, DefaultPassword (must be non-blank), and DefaultUserName. Then set AutoAdminLogon to 1 (all are type REG_SZ). If you ever want to logon as a different user, hold down the shift key as you logoff.

Note: Your password is stored in plain text in the registry and can be seen by someone with the authority to view a remote registry.

2) Get GeoRTD to start running as soon as an account is logged into.

GeoRTD can take a couple of command line arguments. One is the name of a configuration file to be opened, the other is "/go" which does the same thing as hitting the “go” button. Create a new shortcut to GeoRTD, then edit it by right-clicking on it and selecting "Properties." Select the "Shortcut" tab on the "Properties" window. Near the top is an edit box labeled "Target" which has the path to the GeoRTD program. Add to the end of this the path to your configuration file, then "/go". For example,

"C:\Program Files\Geodetics\GeoRTD.exe" "C:\Important Stuff\GeoRTD Data\myconfig.GeoRTD" /go

Now when you double-click this shortcut, GeoRTD should open and immediately run the configuration you specified. To get this to execute when the account is logged onto, simply move it into the "Startup" folder in the start menu. For Windows 2000 and XP, this should be under:

"C:\Documents and Settings\accountname\Start Menu\Programs\Startup"

An additional step must be taken on Windows XP. The device driver for the security key must be modified to load at boot time, before GeoRTD runs. This is done by going into the device manager, selecting “View/Hidden Devices”, expand Non-Plug and Play driver, select properties on Sentinel, and set the Startup type to “boot.

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13.2 File Fragmentation

GeoRTD live modes (Real-time) with file recording enabled will cause file fragmentation. This is unavoidable as multiple files are continually being created and modified to capture and sort incoming data. It is recommended that drives to which GeoRTD is recording data be defragmented periodically. The defragmenter that comes with Windows can be run at the same time as GeoRTD. There are also various utilities available to schedule it to run at specifiable intervals.

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13.3 Using the Data Entry Grid

GeoRTD makes use of a data entry grid on several configuration windows, for example the port assignments for standard RTK:

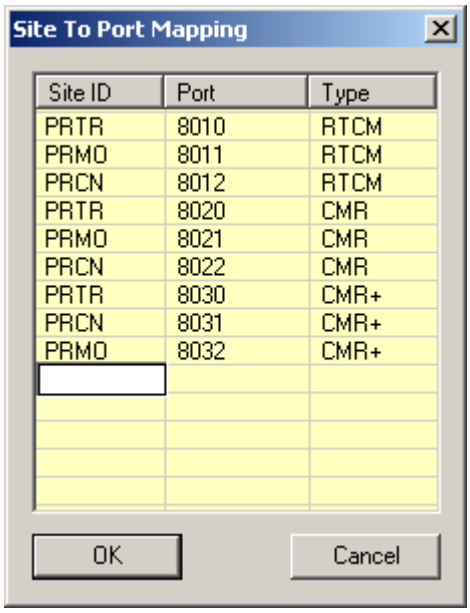

Figure 83 – Data Entry Grid

This grid is used to edit and update related groups of properties in a spreadsheet format. Use of system keys with the data entry grid in general follows behavior elsewhere in Windows and Microsoft Office. The active system keys and their uses for the data entry grid are as follows:

Tab: Accepts modifications to the current grid cell (if any) and moves to edit the next grid cell. If in the last grid cell, the tab key switches to the next control (such as a button or edit box) on the window.

Return: Identical behavior to the tab key.

Shift-Tab: Accepts modifications to the current grid cell (if any) and moves to edit the previous grid cell. If in the first grid cell, the shift-tab key sequence switches to the previous control (such as a button or edit box) on the window.

Shift-Return: Identical behavior to the shift-tab key sequence.

Escape: Cancels any modifications made in the current grid cell and switches to the next control on the window.

Up Arrow: Accepts modifications to the current grid cell (if any) and moves to edit the grid cell in the same column in the next row.

Down Arrow: Accepts modifications to the current grid cell (if any) and moves to edit the grid cell in the same column in the previous row.

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Delete: The delete key can be used to delete an entire row. While editing a cell value, the delete key works as expected until the edit box is entirely empty. If delete key is hit again after all text in the cell edit has already been deleted, the entire row is deleted.

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