GNSS Solutions™

Reference Manual

Includes Tutorial Supplement

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Trimble Navigation Limited
935 Stewart Drive
Sunnyvale, CA 94085

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Chapter 1: Introduction

What is GNSS Solutions?

GNSS Solutions is the indispensable software tool for all surveyors who need to be efficiently and smoothly assisted in their surveys. GNSS Solutions really offers high standards of performance, processing speed, compactness and flexibility. It is extremely user-friendly, simplifying many of the office tasks, a feature which will be appreciated by novice and experienced users alike.

GNSS Solutions can support a wide range of surveying applications, whether conducted in post-processing or real time. What is more, GNSS Solutions is capable of handling post-processing and real-time data within the same project.

GNSS Solutions is also GIS friendly. Any file in ESRI format available for the considered working area can smoothly be imported into the open project as a background map. In addition, raster images of various formats can in the same way be imported as part of the background map thus extending the possibilities for surveyors to present their field results.

Post-Processing:

GNSS Solutions includes components designed to assist you in all stages of planning and post-processing a survey:

- Mission planning
- Data transfer
- Vector processing
- Network adjustment
- Quality analysis

- Coordinate transformation
- Report generation
- Exporting

GNSS Solutions integrates one of the fastest post-processing engines available, as well as superior blunder detection to ensure proper processing the first time. As the processing takes place, GNSS Solutions continuously updates a graphical display to provide a a true representation of your fieldwork.

Real-Time:

GNSS Solutions includes all the necessary tools to prepare a real-time job and upload it to your field unit.

After field operations, GNSS Solutions will let you download the results of your survey into a project so that you can create a report just as you would with your post-processed jobs.

Role of GNSS Solutions in a GPS Survey

Post-Processing:

Once you have conducted your survey, GNSS Solutions provides the ability to accurately determine site locations within the parameters you establish. With the post-processing completed, GNSS Solutions allows you to perform blunder detection, adjust your network, and review quality metrics.

Once the automatic processing is complete, GNSS Solutions transforms your raw data into a polished final report that can be produced in a variety of formats to suit the client's needs.

Real-Time:

Before the survey, you can use GNSS Solutions to prepare the field job, i.e. create a file containing the job's target and reference points and then upload this file to the field equipment.

After the survey, you can download the results to a project and create the final report for your customer. You may combine these results with post-processing results in a single project. If raw data was recorded during the real-time survey, you can even re-process the data as you would with post-processing data for double-checking.

Utility Programs Provided

Different built-in tools are provided in GNSS Solutions. They are used to:

- Edit / manage coordinate systems used by GNSS Solutions
- Transform coordinates from a known system to another known system
- Set leap seconds involved in the GPS-to-UTC time conversion at any given date
- Transform GPS week & time into local date & time.

In addition, GNSS Solutions is delivered with 7 separate utility programs:

- **Mission Planning** is used to depict the GPS constellation seen from any given point located on the Earth surface, at any given time in the past or future. **Mission Planning** provides both qualitative and quantitative figures about the constellation then visible.

  You can then use **Mission Planning** to choose the best moment to perform a survey. In addition, the Curtain function allows you to simulate the impact of close obstructions on the number of usable satellites, on the GDOP, etc.

Mission Planning can also be used when post-processing files as a monitoring tool, for example for better understanding of what happened when logging the raw data files.

- **WinComm** is used to communicate with a Spectra Precision GNSS receiver, directly from the PC to which it is attached, via the set of proprietary commands available (NMEA 0183 compatible). From WinComm, you can check / modify the receiver settings (configuration) or run raw data recording sequences in manual or automatic mode.
- **Geoids** allows you to exploit most of the geoid models existing to date. In practice, you can use **Geoids** to extract part of the data from a geoid model, according to the geographical region you choose, and load this data directly to the Spectra Prec. receiver or data collector for further use in the field. In this way, any position fix performed in reference to the ellipsoid will be corrected through this model to give elevation.
- **RINEX Converter** is used to translate single or multiple RINEX-formatted data files to “Ashtech”-formatted files, and, alternatively, convert "Ashtech" data files to RINEX format.
- **DSNP to RINEX (DTR)** is used to convert GNSS raw data files (DSNP SBIN, SVAR, SFIX) into RINEX-compatible files for further use in any other system compatible with the RINEX format.
- **GNSS Download** is used to download field raw data to your computer. While doing this, GNSS Download analyzes and splits the raw data into different types of files (e*, b*, etc.).
- **SurvCom** is used to perform data exchange between GNSS Solutions and the data collector of the ProMark 500 or Z-Max system. This utility program allows data exchange in both directions of transfer.
- **Internet Download** allows you to download compact RINEX raw data, or precise orbit files from the FTP site you choose.
- **Project Management** allows you to manage your projects (delete/backup/restore).

Minimum System Requirements

- Personal Computer, PC type
- Operating system: Windows 2000 / XP
  Warning! Installation on XP operating system must be run with the administrator login otherwise some GNSS Solutions functions won't work.
- Processor: Pentium 233 or 300 MHz recommended (*)
- RAM: 64 or 128 MB recommended (*)
- Space required for installation: 200 MB
  Warning! Allow for a minimum of 124 MB on disk C: when you install GNSS Solutions on a different drive. Whatever the installation disk you choose for GNSS Solutions, this 124-MB space is always required on disk C: for common files.
- CD-ROM drive
- PC card drive is recommended if you use receivers collecting their field data on PC Cards
- RS232 or USB serial ports

(*) Recommended by Microsoft for XP and sufficient for GNSS Solutions.

Customizing GNSS Solutions

GNSS Solutions can be customized using the **Tools>Preferences** command.

With the default configuration installed, GNSS Solutions is more particularly intended for post-processing surveys. The Insert Background Map function is also available in this case.

There are four additional features that you can validate through customization, depending on your needs: 1) RTK, 2) Data Management, 3) CAD and 4) Advanced Coordinate System Management. These features are described in Chapters 7, 11 & 12 in this manual.

Installing GNSS Solutions

- Close all the applications running in Windows
- Insert the GNSS Solutions CD-ROM in the drive. The Autorun program should normally start automatically. If an earlier version of GNSS Solutions is present on your computer, the installation program will first ask you to uninstall this earlier version. You will then have to re-launch manually the installation program.
- If the Autorun program does not start automatically from the CD-ROM, in the Windows task bar, click on **Start** and select **Run...**
- Type **x:\setup** (where **x** is the name of the CD-ROM drive) and then press **Enter**. After you specify where to install GNSS Solutions programs and projects, your computer will complete the installation process.
- **Before launching the program, don't forget to connect the dongle to the PC's parallel or USB port, depending on the model of dongle you ordered**. (This dongle is part of the delivery if you have ordered a protection of the hardware type.)

  With an absent dongle, GNSS Solutions will however run full-featured for 30 days. After this grace period, GNSS Solutions will refer to the content of the dongle to know which options are really enabled, depending on the detail of the purchase. Obviously, if the dongle is still missing at that time, the "L1/L2 Post-Processing" option will not be made available to the user even if he bought it. Only the presence of the dongle will "tell" the software this option can be unlocked.

ProMark3 users do not need to worry about the grace period or the use of a dongle. Their equipment is a single-frequency receiver and so does not require that the "L1/L2 Post-Processing" option be unlocked in GNSS Solutions.

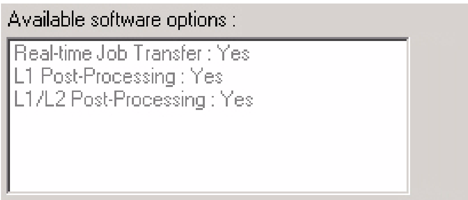
Dongles are well suited for sedentary users, especially for those who wish to use GNSS Solutions on two or more of their office computers.

Conversely, users that travel extensively may be interested in having software protection devices installed on their PCs rather than easily mislaid dongles.

See *Using a License File Rather Than a Dongle on page 9* for more information on this protection choice. Remember however that the software-type protection cannot be moved from one PC to another as it is closely tied to the PC hardware.

- To list the available software options after installation, launch GNSS Solutions. To start GNSS Solutions, from the Windows task bar, select successively **Start**, **Programs** and **GNSS Solutions**. Once the GNSS Solutions main window is open, on the GNSS Solutions menu bar, select **Help>About GNSS Solutions**. The dialog box that appears lists all the possible options. Each option is followed by its current status: **Yes** means the option is enabled; **Yes - xx day(s)** means the option is enabled for xx days only; **No** means the option is disabled.

  In the example below, all the options are available for use:

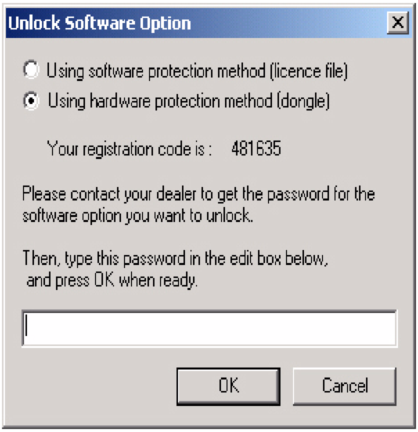


Please note that the “Real-Time Job Transfer” and “L1 Post-Processing” options are always valid even after the grace period has expired.

❑ Unlocking a Software Option

After a certain time using your GNSS Solutions program, you may need to unlock the L1/L2 processing option that you did not initially purchase. After ordering this new option, do the following:

- On the GNSS Solutions menu bar, select **Help>About GNSS Solutions**
- In the **About GNSS Solutions** dialog box that opens, click on **Click here to unlock options**. A new dialog box opens, which should look like the one below if a dongle is connected to the PC's USB or parallel port:

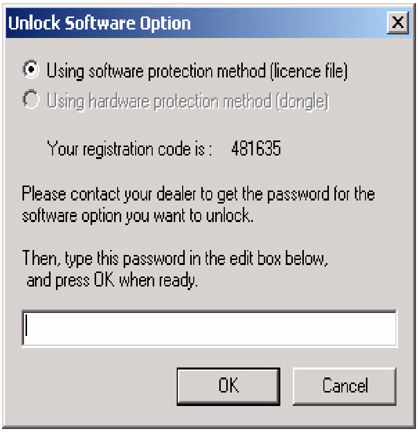


- To get the password needed to run the "L1/L2 Post-Processing" option, and also to be registered as a GNSS Solutions user, write down your registration code (displayed in third line in dialog box above) and then click on the web link. If your PC is equipped with a connection to the Internet, you will be able to access our web site to make your request. From the registration code you will send us, we will be able to generate a password for you. Once you receive it, type in this password in the lower edit box (see dialog box above) and then click **OK.** This unlocks the software option making it available for use.

❑ Using a License File Rather Than a Dongle

For those of you who prefer not to use a dongle and have their options enabled from a license file, do the following the first time you run GNSS Solutions:

- On the GNSS Solutions menu bar, select **Help>About GNSS Solutions**
- In the **About GNSS Solutions** dialog box that opens, click on **Click here to unlock options**. A new dialog box opens, which should look like this in the absence of a dongle on the parallel or USB port:



- To get the password needed to run the “L1/L2 Post-Processing” option, and also to be registered as a GNSS Solutions user, write down your registration code (displayed in third line in dialog box above) and then click on the web link. If your PC is equipped with a connection to the Internet, you will be able to access our web site to make your request. From the registration code you will send us, we will be able to generate a password for you. Once you receive it, type in this password in the lower edit box (see dialog box above) and then click **OK.** This unlocks the software option you have purchased, thus making it available for use.

What Do I Do First?

If you are transitioning from standard surveying techniques to GNSS, you may find GNSS technology baffling or even intimidating. However, once you become familiar with the basic techniques, you will find that GNSS is a powerful productivity tool. The following scenario is recommended for users new to GNSS.

1. Skim through all the GNSS Solutions documentation to familiarize yourself with content and organization.
2. Following the instructions in the receiver manual, use the receiver to do an actual miniature survey, such as a parking lot or park.
   - OR -
   Spend some time working through the examples in the tutorial to understand the reasoning and terminology underlying GNSS Solutions.
3. Transfer your data to your PC, and run GNSS Solutions software as instructed in the present Reference Manual.
4. Print out your data in the format that you want. ❑

Chapter 2: Getting Started

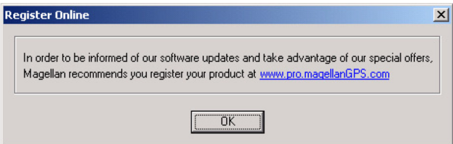
This chapter describes the fundamentals of GNSS Solutions, including starting the software, navigating through the software, and using the various windows. It is assumed that GNSS Solutions was installed with the default choices.

Starting GNSS Solutions

To launch GNSS Solutions, double-click the GNSS Solutions icon located on your computer workspace:

Or from the Windows task bar, click on **Start**, then **Programs**, then select **GNSS Solutions** and then **GNSS Solutions** again.

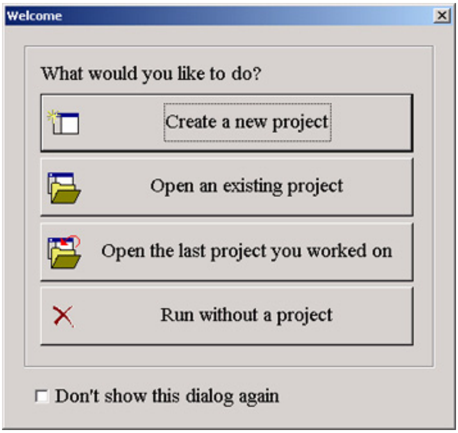
The GNSS Solutions splash screen appears momentarily, followed by the Register Online dialog:



This box will only appear the first time you run GNSS Solutions, i.e. just after installing this program. You will still be able to display this dialog by selecting **Help>Register Online**.

Clicking on the web link will directly take you to a web page on our web site –provided your computer has an operating Internet connection– where you will be able to fill out a contact form. As prompted in the dialog, it is highly recommended to fill out this form as it will give you significant advantages.

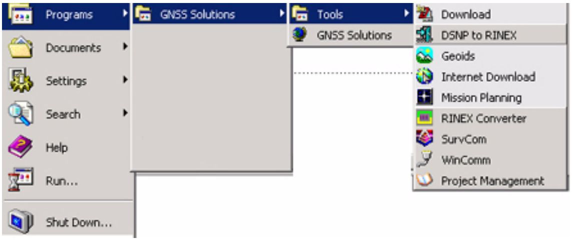
After filling out the web form, come back to the GNSS Solutions window. Click **OK** in the Register Online box. The Welcome dialog is now displayed, as shown below.



You use this dialog to open an existing project, create a new project, open the last project you worked on, or run GNSS Solutions without a project.

Accessing Utility Programs

While using GNSS Solutions, you will sometimes need to run a utility program. To run one of these programs, from the Windows task bar, click on **Start**, then **Programs**, and then select Tools. The screen will display a number of utilities at this point, as shown in the figure below.



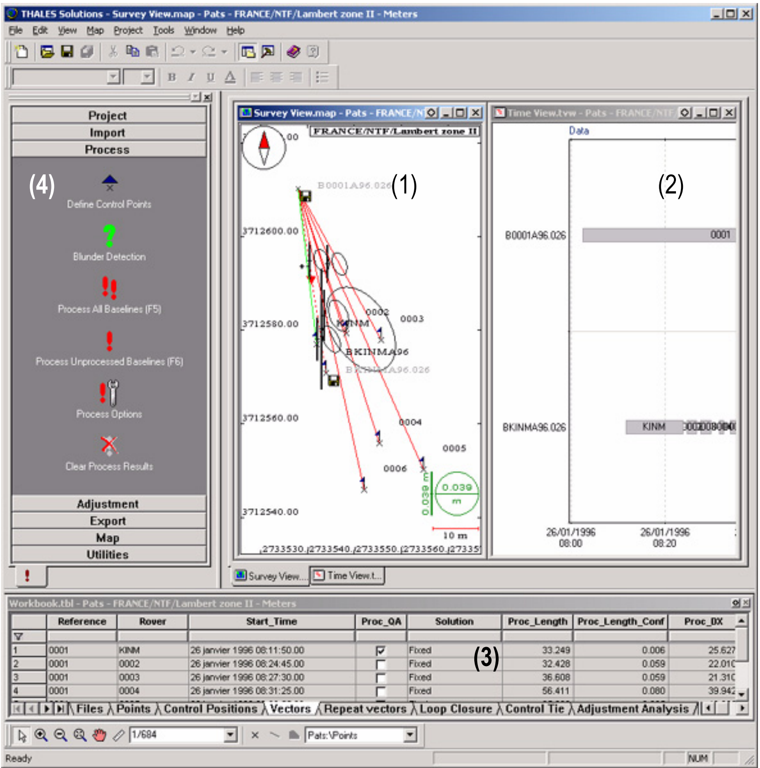
Run the desired utility by making the appropriate selection in the menu.

Quitting GNSS Solutions

You can quit GNSS Solutions at any time by selecting **Exit** from the **File** menu. GNSS Solutions will automatically save the project you were working on.

Navigating Through the Software

The GNSS Solutions main display has three windows to view and work with your data: the **Survey View** window (1), the **Time View** window (2) and the **Workbook** window (3). You need to open a project in GNSS Solutions to view these three windows. (See figure below.) All the tasks necessary to successfully process and adjust your data can be accomplished within these windows. Additionally, the **Command pane** (4) allows you to easily access the right command at the right time.



Use the following tools to control the layout of the different views within the GNSS Solutions main window:

- The **View>As Workbook** option allows you to fit the views with tabs. (All the tabs are grouped at the bottom of the view windows). You can then easily display a view by simply clicking on the corresponding tab.

  If you clear the **View>As Workbook** option, all tabs disappear from the main window but you can still read the list of available views in the **Window** menu. If you close a view, you will be able to re-open it by selecting this view in the **Window** menu.
- The Dock button () located in the right-upper edge of each view allows you to keep this view always visible. Once you have docked the view, move it to the desired location by dragging it from its title bar. While dragging, GNSS Solutions will draw an empty frame indicative of the final size and shape of the view, depending on where the mouse cursor is. When you agree with the location and shape, just release the mouse button and the view will appear where desired. You can dock several views at a time.
- The **Window>Cascade**, **Tile Horizontally** & **Tile Vertically** options apply to the displayed views regardless of whether **View>As Workbook** is checked or not. These options do not affect the view docked to the GNSS Solutions main window (if there is one).

When you launch GNSS Solutions for the first time, and as long as you do not clear this option, the **View>As Workbook** option is checked.

When you create a new project, GNSS Solutions creates and opens a number of views that are organized as follows:

- Survey view and Time view shown in the upper-right part of the GNSS Solutions main window
- Workbook docked to the lower part of the GNSS Solutions main window.

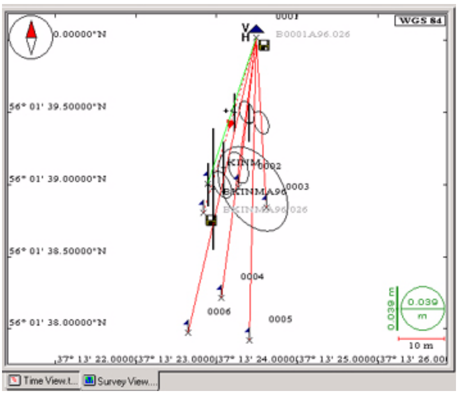
Using the Survey View Window

The Survey View window displays points (sites), baselines, vectors, error ellipses and observation files from the open project.

When the zoom setting is appropriate, the Survey View also shows the positions of reference stations located in the vicinity of the project. Reference stations are represented as yellow and blue triangles:

For more information on reference stations, see *Corrections Providers & Reference Stations on page 219*.

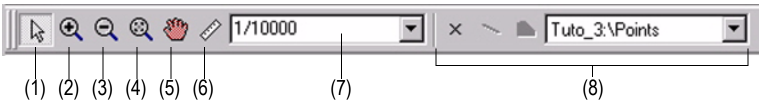
When you move the mouse over the Survey View, you can continually see the coordinates of the mouse cursor in the status bar at the bottom of the GNSS Solutions main window. These coordinates are expressed in the coordinate system defined for the project (see *Creating a New Project on page 35*).



❑ Map Toolbar and Other Controls

The following tools are associated with the Survey View:

A. Map Toolbar located at the bottom of the screen:



(1): **Select** tool: Selects one or more objects shown on the map. Multiple selection is accomplished either by dragging the mouse cursor around the desired objects or by selecting the objects one after the other. You have to hold down the Shift key to add new objects to the first selected object.

(2) **Zoom In**: Zooms in on the area where you click or drag. You can also drag a rectangle around the desired area to adjust the scale accordingly.

(3) **Zoom Out**: Zooms out from where you click or drag

(4) **Zoom To Fit**: Adjusts the map scale so that all the visible objects present on the map can be seen

(5) **Grabber** tool: Shifts the map as instructed. The map shift directly results from the length and orientation of the segment you drag on the map.

(6) **Distancemeter** tool: Measures the distance between two points that you indicate with the mouse. To use this tool, hold down the mouse button on the first point and then drag the mouse to the second point. The tool then continually indicates the distance between the start point and the current position of the mouse cursor.

This function uses gravity to help you position the mouse cursor exactly on the two points (points act as magnets that attract the mouse cursor when located in the vicinity). Distance measurements are expressed in the unit chosen for the project.

(7) **Scale factor**: choose a preset value from the combo box. Clicking on the zoom-to-fit button will also cause the scale factor to be up-dated to reflect the changes then produced

(8) **Draw Point** tool (see *Adding a New Point to the Project on page 25*)

B. The same tools are available from the popup menu attached to the Survey View (right-click anywhere within the view to access this menu), as well as from the **Map** menu on the GNSS Solutions menu bar.

C. The mouse wheel combined with the following keys:

- The mouse wheel used alone drags the map vertically, upward or downward depending on the direction in which you rotate the wheel
- The mouse wheel combined with the depressed **Shift** key drags the map horizontally, to the left or to the right, depending on the direction in which you rotate the wheel
- The mouse wheel combined with the depressed **Ctrl** key zooms in or out on the map, keeping the map's central point immobile. You zoom in or out, depending on the direction in which you rotate the wheel.

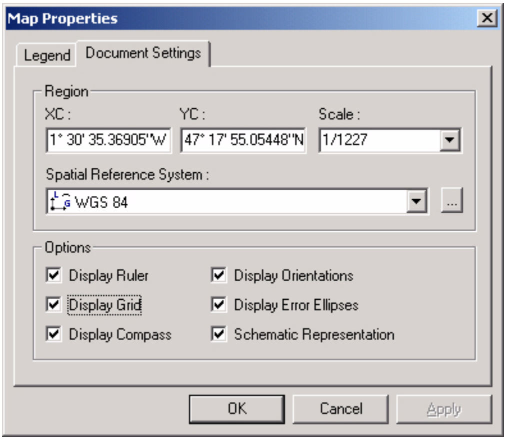
D. The following keys on the numeric pad:

- The + key to zoom in
- The - key to zoom out.

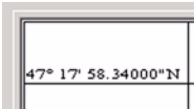
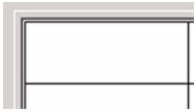
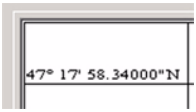
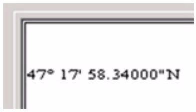
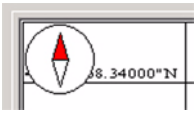
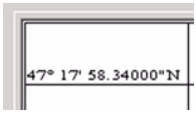
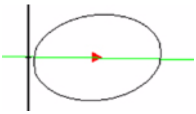
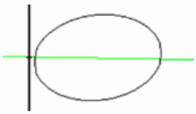
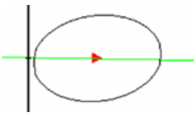
❑ Changing the Viewing Settings

The Survey View has a number of viewing options that you can change at your convenience.

Right-click anywhere within the Survey View and select **Document Settings** in the Popup menu. This opens the Map Properties window shown below:



The viewing options, grouped at the bottom of the window, are described in the table below:

Setting	Description	Resulting View with Button Checked	Resulting View with Button Cleared
Display Ruler	Shows/hides grid coordinates on the map.		
Display Grid	Shows/hides grid lines on the map.		
Display Compass	Shows/hides the compass on the map. The compass is always shown in the upper-left corner.		
Display Orientation	Shows/hides the arrow indicating the orientation of each vector displayed on the map.		
Display Error Ellipses	Shows/hides the error ellipse relevant to each vector.		
Schematic Representation	Performs two different functions: 1) Redraws vectors so that they all precisely connect to the expected points or keeps them as determined.		
	2) Relocates observations, i.e. moves observation icons and associated filenames next to the points or keeps them at their original locations. See Notes below for more detail.		

In case of loop misclosure, you may want to see all the concerned vectors join up at the same point on the Survey View although the process results show that these vectors do not exactly converge. To obtain such a simplified view, you just need to check the **Schematic Representation** *option.*

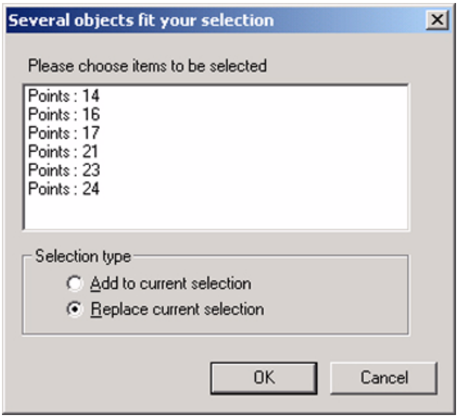
Each observation file is represented on the map by a diskette icon and a filename next to it. Before processing, GNSS Solutions locates the icon and filename on the map according to the sole observation data present in the file (in fact an autonomous GPS solution is determined from this data). After processing, GNSS Solutions accurately locates each vector on the map but keeps the relevant observation icon and filename at the initial location. To avoid any confusion and simplify the view, you can move the observation information next to the point by checking the **Schematic Representation** *option.*

The following settings can also be made from this window:

- Changing the coordinates of the point occupying the middle of the map. This is equivalent to using the Grabber tool on the map toolbar (see *Map Toolbar and Other Controls on page 17*).
- Changing the map scale. This is equivalent to using the Scale factor box on the map toolbar (see *Map Toolbar and Other Controls on page 17*).
- Choosing a coordinate system specific to the view, i.e. without affecting the choice of coordinate system you made at project level.

❑ Selecting an Object on the Survey View

- To select an object on the Survey View, click on the Map toolbar (or select this button on the **Map** menu), and then click on the desired object on the map document.
  If the area where you click is not populated with too many objects, then GNSS Solutions will be able to find the object you want to select and will highlight it on the map when it is identified.
  If the area is densely populated with objects and you click on this area, GNSS Solutions will do one of the following:
- If the number of objects close by is less than 6, a popup menu will be displayed listing the names of these objects. You will just have to select the desired object by clicking on its name in the popup menu.
- If the number of objects is greater than or equal to 6, a new dialog box will open listing all the possible objects found in this area. You can then tell the software which object you would like to select. Below is an example of what this dialog box looks like:



- In this case, just select the desired object in the list, specify the selection type (**Add to...** or **Replace current selection**) and then click **OK** (you can also directly double-click on the desired object in the list to select it). As earlier mentioned, GNSS Solutions will then highlight the selected object on the map document so you can proceed.

  If you zoom in sufficiently on the area before trying to select an object, GNSS Solutions will readily find the object without having to resort to the above dialog box.

❑ Point Types and Symbols Used on the Survey View

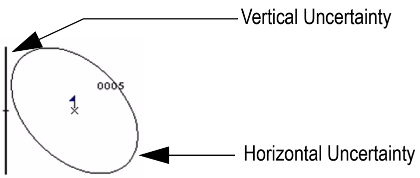
Icon	Type
	Logged Point
	Intermediate Point
	Control point:
	- Not fixed
	- Fixed vertically
	- Fixed horizontally
	- Fixed vertically and horizontally
	Reference Point Before Survey
	Reference Point After Survey
	Target Point Before Survey
	Target Point After Survey

❑ Vector Conventions Used on the Survey View

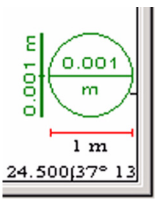
On Survey View	Line Type & Color
Unprocessed	Thin, dashed, red (baselines)
Processed	Thin, green - Processing QA pass Thin, red- Processing QA fail
Adjusted	Thick, green- Adjustment QA pass Thick, red- Adjustment QA fail
Loop	Thin, double gray
Selected	Thin, double, dark-blue
Excluded	Thin, gray (disabled vectors)

❑ Error Displays

After you adjust the network, the vertical and horizontal error is displayed for each point. Horizontal error is represented as an elliptical region around the point, and estimates real error on the ground. Vertical error is represented as a bold black line; the longer the line, the greater the error.

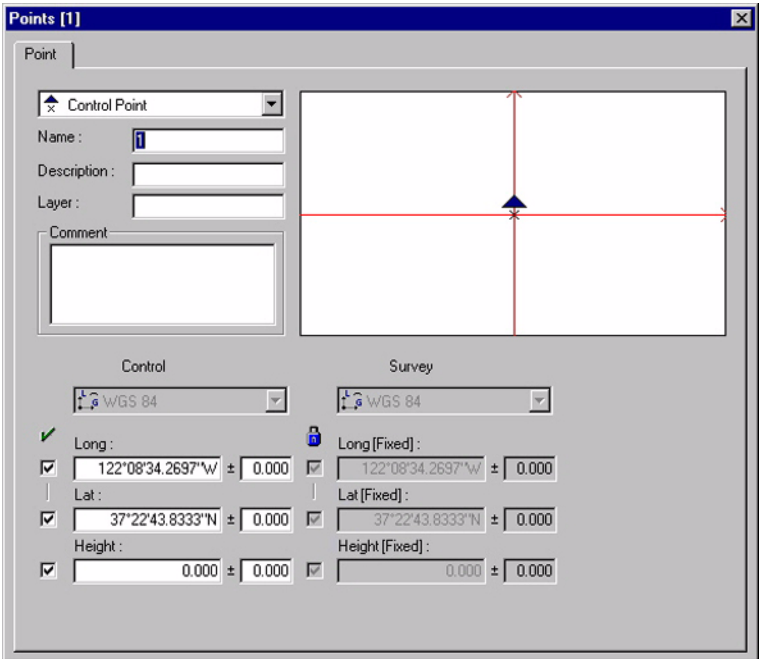


The Survey View window constantly displays the error legend (bottom right) allowing you to readily estimate these errors. The error legend is updated whenever you change the zoom settings of the Survey View.



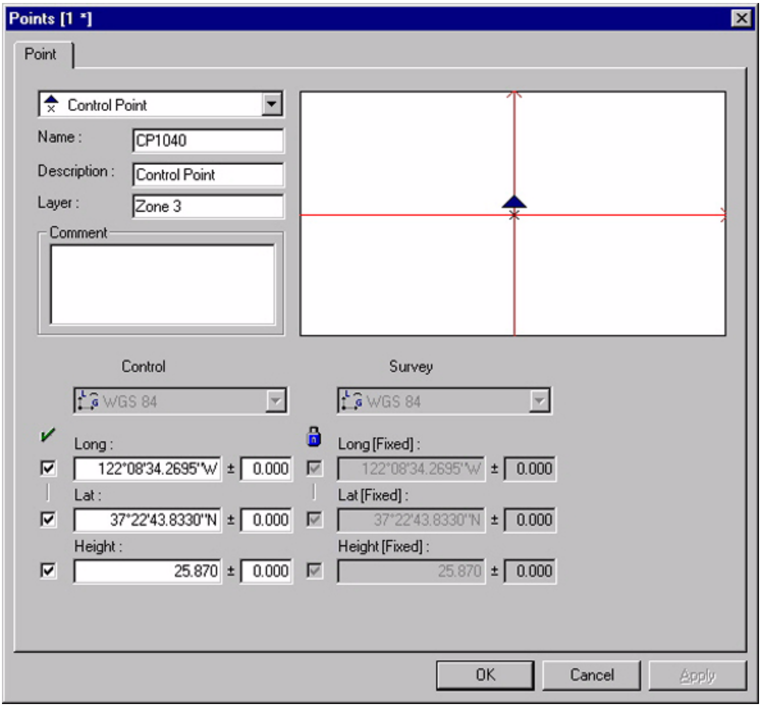
❑ Adding a New Point to the Project

- Click anywhere on the Survey View
- On the Map toolbar at the bottom of the screen, click ×
- Move the mouse cursor over the map and left-click where you want to create the new point. A new dialog box opens showing the coordinates of the new point resulting from where you clicked on the map.



In this dialog box, GNSS Solutions prompts you to create a fixed control point, i.e. the control coordinates that result from where you have just clicked on the map are also defined as the point's survey coordinates.

- If the displayed control coordinates are not exactly those of the control point, correct these coordinates in the dedicated fields. If the control point is a 3D point, check the Height check box and type the known Height coordinate for the point.
- Complete the fields, top left, defining the control point. The dialog box might then look like this:



Geographical coordinates can be typed in using one of the following three formats (<sp> stands for “space”,):

- DDD.DDDDD<N/S or W/E>
- DDD<sp>MM.MMMMM<N/S or W/E>
- DDD<sp>MM<sp>SS.SSSSS<N/S or W/E>

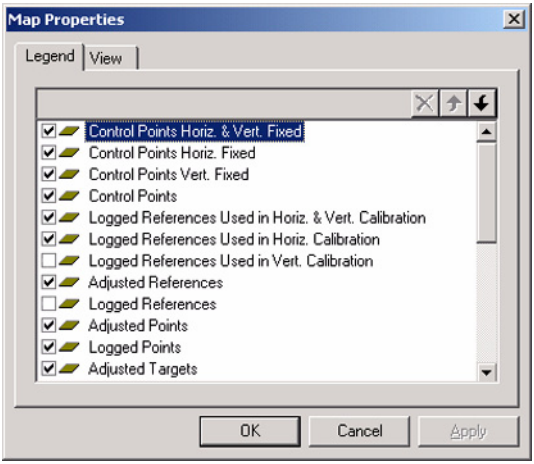
Where:<sp>: space, D: Degree digit, M: Minute digit, S: Second digit, <N/S or W/E>: North or South for latitude, West or East for longitude.

Whatever the format you choose when typing in your coordinates, GNSS Solutions will always use the DDD°MM”SS.SSSS<N/S;W/E> format when later on you re-open this Point Properties window.

- Click **OK**. The new point now appears on the map. Its representation on the map is in compliance with *Point Types and Symbols Used on the Survey View on page 23*.
  You can quickly add as many points of the same type as needed by holding down the **Shift** key and clicking repeatedly on the map where you want these points to be created. In this case, GNSS Solutions skips the display of the **Points** properties dialog box and automatically creates the points.

❑ Showing/Hiding Items on the Survey View

- On the map pop-up menu, select **Legend**. This dialog box provides the list of all the possible items. If the button before each item name is checked, then all these items will be visible on the Survey View. Conversely, if this button is cleared, none of these items will be visible.



❑ Deleting a Point from the Survey View

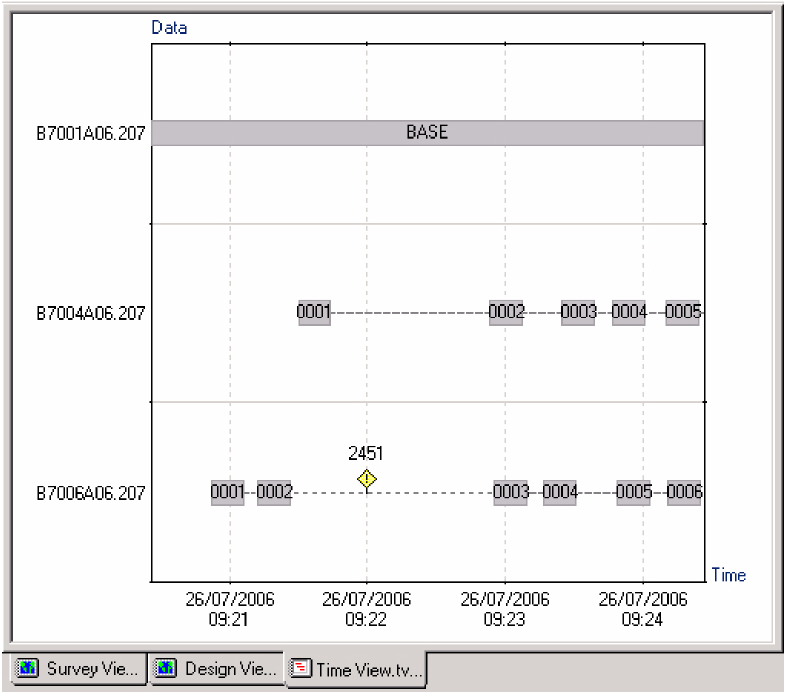
- On the Survey View, select the point you want to delete
- Press the **Del** key or on the menu bar, select **Edit>Delete**. A warning message appears asking you to confirm your choice
- Click **Yes** to allow GNSS Solutions to delete the point.

❑ Viewing the Reference Stations Located in the Vicinity

- Just zoom out until you can see them (if there are any).

Using the Time View Window

The Time View window displays the observations for each file loaded into the project. This display provides a quick and easy look at the observation time for each site:



The horizontal axis of the Time View window shows the date and time of data collection.

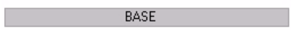
The vertical axis of the Time View window provides the file name of each observation. The diagram shows the duration of each observation. Inside each static observation is the name of the point where the observation took place.

An observation file may consist of one or more *occupations* which are basically either static or kinematic. The following graphic conventions are therefore used to represent the different possible occupations in an observation:

- *Bars* for static occupations.
- *Continuous lines* for kinematic occupations.
- *Dotted lines* for *excluded* occupations corresponding to intervals of time for which GNSS Solutions is not expected to produce any result (points or trajectory). Excluded occupations are usually the periods of time during which field operators have to move from one point to the next (typically Stop & Go Surveys).

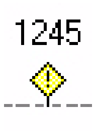
  Remember that for the sake of preserving system initialization throughout field operations, the field equipment has in fact to continuously collect data, including during those idle periods of time.
- *Short vertical lines* separate kinematic occupations from excluded occupations.

The table below shows how these conventions are used in typical cases of surveys.

	Static (base, rover): a single bar.
	Stop & Go (rover): static occupations separated by excluded occupations.
	Kinematic (rover): a single line.
	Kinematic (rover), two trajectories collected in the same data file with a pause in between: two lines separated by an excluded occupation.

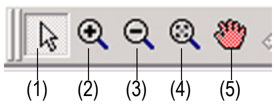
You can double-click any occupation in an observation to view its information. In case of ambiguity on which occupation you clicked or double-clicked, GNSS Solutions opens a dialog asking you to choose an occupation. Choose the desired one from the prompted list and click **OK**. Then right-click and select **Properties** to view the information pertaining to this occupation.

An observation file may include events. Events are time markers represented on the Time view as warning road signs (see below). Like occupations, events can be edited in GNSS Solutions (see *Observation Properties on page 67*):



The following tools are available to work in the Time View:

A. Map Toolbar located at the bottom of the screen:



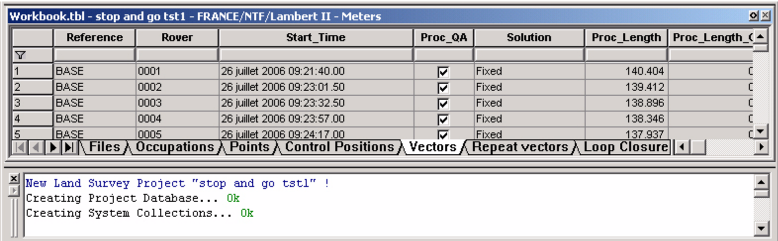
(1): **Select** tool: Selects an item shown on the Time View.
(2) **Zoom In**: Zooms in on the area where you click or drag
(3) **Zoom Out**: Zooms out from where you click or drag
(4) **Zoom To Fit**: Adjusts the map scale so that all the visible objects present on the Time View can be seen
(5) **Grabber** tool: Shifts the view as instructed. The map shift directly results from the length and orientation of the segment you drag on the view.

B. The same tools are available from the popup menu attached to the Time View, as well as from the **Time** menu on the GNSS Solutions menu bar.

You can also split an occupation into more occupations so you can process these occupations separately or reject them from the processing. See *Filtering Occupations on page 75* for more information.

Using the Workbook Window

The **Workbook** window has tabs to display different kinds of information, from coordinates to network precision statistics.



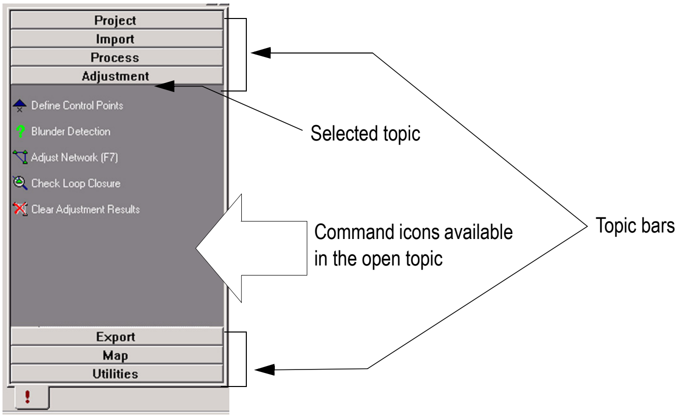
- Switch between displays by clicking a different tab.
- Double-click on any column header to sort the data in ascending or descending order.
- Right-clicking in any column or highlighted row gives access to a menu allowing you to select one of the following functions:
  - **Tabs**: to define the tabs you want to include in or exclude from the Workbook window.
  - **View**: to change the coordinate system used in the Workbook window (and not at project level)
  - **Data**: To define the data columns you want to show/hide in the displayed tab
  - **Sort**: To sort the data rows in the viewed tab according to 1 to 3 different criteria
  - **Properties**: (for a highlighted row only) To view the properties of the item displayed in the highlighted row.

- Highlighting a row in a Workbook tab –by clicking in the leftmost cell- highlights the corresponding item displayed in the Survey View. For example, clicking in the leftmost column of a Point row in the **Points** tab highlights this point in the Survey View.

Output pane:

Below the Workbook is the Output pane, which displays summary information, activity log information, and warnings. Although the text is not editable, you can select text and copy to the clipboard or other applications by right-clicking.

Using the Command Pane



The **Commands** pane is designed to help you choose the right command at the right time. The available commands are organized by topic and are in fact those accessible from the GNSS Solutions menu bar -more particularly those from the **Project** menu- but here they are shown as icons, with command names displayed after icons. To run one of these commands, simply click the icon.

The number of topics contained in the tab is context-sensitive. Among these topics is the Utilities topic, permanently available, and that you can customize using the command **Tools>Customize...** (**Tools** tab). To open a topic when several topics are available, click the horizontal topic bar showing the name of the topic.

For the sake of conciseness, we will generally mention in this manual how to access a command by navigating through the menus (the ">" symbol will be used between the different selections you have to do to access a command; e.g. **Project>Check Loop Closure***). You must be aware though that most commands can more quickly be accessed through the Command pane.* ❑

Chapter 3: Projects

GNSS Solutions uses a **Project** for manipulating data files and for processing site locations. This chapter describes the creation, modification, and manipulation of a project once you have collected survey data with a GPS receiver. It is still assumed that you installed GNSS Solutions with the default choices.

A project can be considered a repository for raw data files (received from GPS receivers) and site information (site IDs, site names, and antenna heights) recorded in the handheld or manually in a logbook.

If you are creating a new project, proceed to the next paragraph below. If you want to access an existing project, refer to *Opening an Existing Project on page 43*.

Creating a New Project

You can create a new project at startup or any time the software is running.

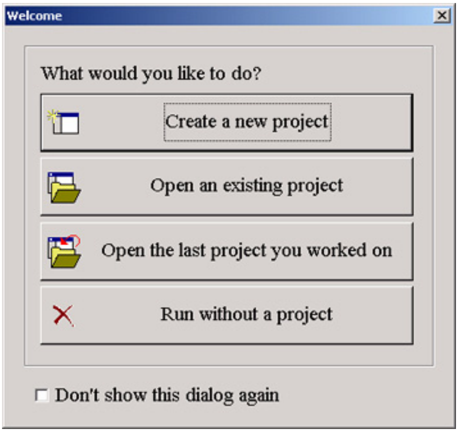
To create a project with GNSS Solutions running:

- Type Ctrl+N, or
- Click the New button on the toolbar, or
- Select **New** from the **File** menu. This closes -and saves- any open project and opens a new project. Go to Step 2 to continue with the project setup.

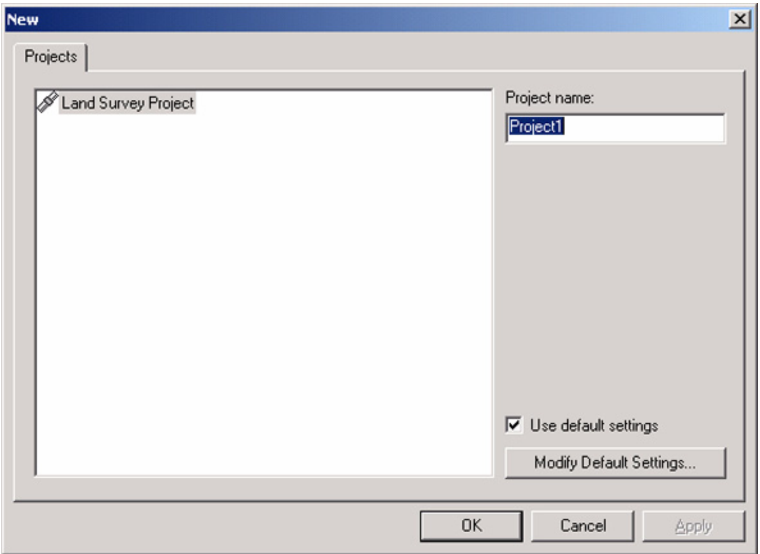
To create a project at startup:

1. Start GNSS Solutions from the Windows task bar by selecting successively **Start>Programs>GNSS Solutions>GNSS Solutions**.

A momentary screen opens, followed by the Welcome dialog shown below:

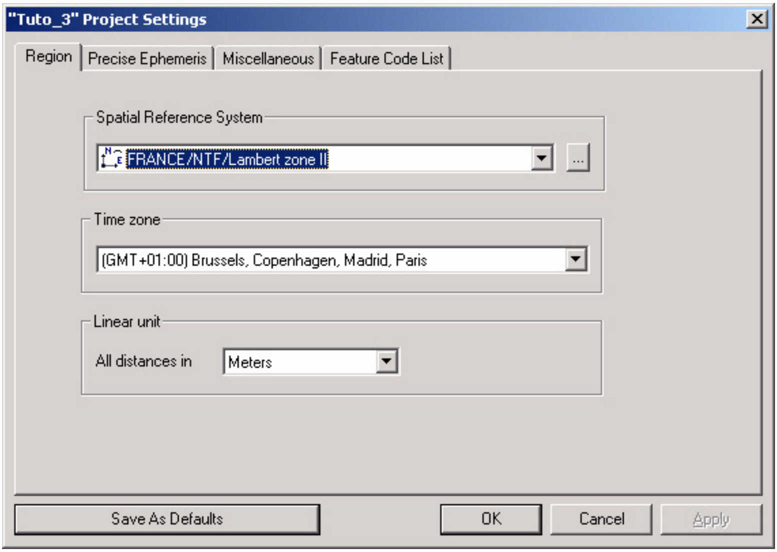


2. Click on **Create a new project**. The **New Project** dialog appears.



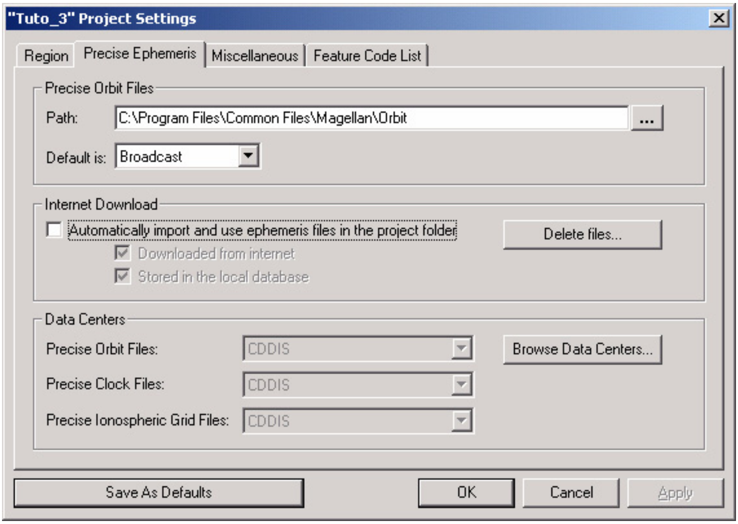
This tab allows you to enter the name of the new project, e.g. Smith Survey

3. In the same dialog, click on **Modify Default Settings**. Note that the new dialog presents three tabs: **Region**, **Precise Ephemeris** and **Miscellaneous**.



The **Region** tab lets you define the coordinate system. The defaults, WGS84, GMT+01:00 Time Zone and Meters unit, appear the first time you use the software. You can change these parameters to your preferred settings, after which your preferred settings become the new defaults. Refer to *Chapter 7: Coordinate Transformations on page 119* for more information about coordinate system settings.

4. Click on **Precise Ephemeris** to switch to the Precise Ephemeris tab (see below).



This tab contains the three data subsets described below:

- **Precise Orbit Files**:

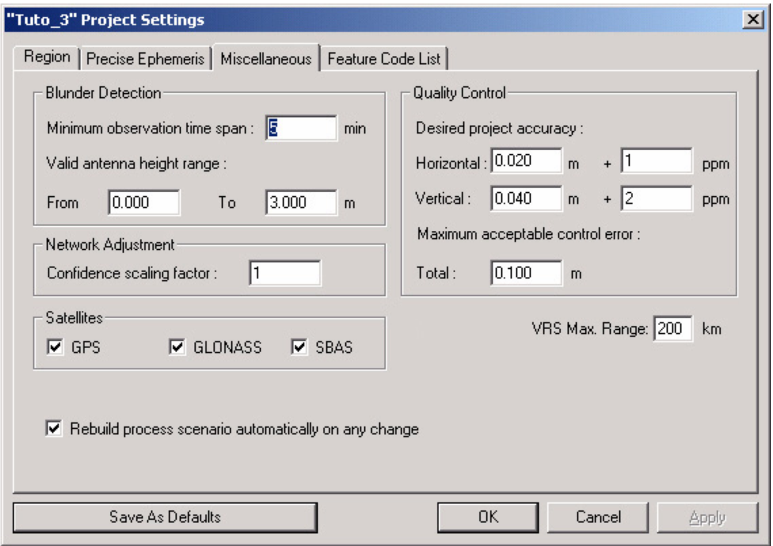
Path	Use this field to specify the path and folder where GNSS Solutions can find the precise orbit files (in SP3 or EF18 format). This field is irrelevant to broadcast orbits. If **Automatically Import and use ephemeris files in the project folder** is enabled (see below), then **Path** is automatically set to provide the path to the folder of the open project and you are not allowed to change it. If **Automatically Import and use ephemeris files in the project folder** is disabled, then **Path** is automatically set to the default orbits folder but you can choose another path if you wish.
Default is	Use this field to specify the type of precise orbit data to be used by default in the project. There are three possible choices: - Broadcast (default choice)(orbit data from satellites) - Precise SP3 - Precise EF18

- **Internet Download**: Use this subset to tell GNSS Solutions how to deal with ephemeris files.

Automatically import and use ephemeris files in the project folder	If enabled, this option asks GNSS Solutions to use the ephemeris files stored in the project folder. When enabling this option, you may also set the two parameters below.
Downloaded from Internet	If enabled, this option will allow GNSS Solutions to import ephemeris files from the Internet if the required file cannot be found in the project folder. GNSS Solutions will use a software submodule from Internet Download to perform this operation. Messages will appear on the screen when files are downloaded from the Internet to the project folder.
Stored in the local data base	If enabled, this option will allow GNSS Solutions to import ephemeris files from the local database if the required file cannot be found in the project folder. The local database is located in the ...\Program Files\Common Files\Ashtech\Orbit folder and cannot be moved elsewhere. This option can be used with the **Downloaded from Internet** option also enabled. In this case, GNSS Solutions will first search for the file in the local database. If it cannot be found there, then the file will be downloaded from the Internet, if it's available.
Delete files...	Use this button to delete all ephemeris files from either the local database or project folder, or from both. Two options are available: **Delete Ephemeris stored in the local database**: If checked on, all ephemeris files stored in the local database will be deleted after you click OK. **Delete Ephemeris stored in the project folder**: If checked on, all ephemeris files stored in the project folder will be deleted after you click OK.

- **Data Centers**: This data subset needs to be set only if the **Automatically import and use ephemeris files in the project folder** option is enabled. Each ephemeris data type can be downloaded from a different data center.
  The Browse Data Center button allows you to access a database from which you can view the characteristics of each of the available data centers. See also *Adding an Ephemeris Data Center on page 46*.
  GNSS Solutions will always try to get the most precise data from a given data center. In order of preference, the following files will be imported if they are all available from the chosen data center: 1) Final, 2) Rapid, and 3) Ultra-Rapid.
  A warning message will appear in the GNSS Solutions output pane if precise data normally available from a data center cannot be delivered at the time of request.

5. Click on **Miscellaneous** to switch to the Miscellaneous tab (see below)



This tab contains the four data subsets described below:

- **Blunder Detection**. Define the two criteria required to run the Blunder Detection test:

Minimum observation time span	Minimum amount of observation time in a data file allowing this file to be imported. Enter a value in minutes (default: 5 minutes). For example, if this value is 15 seconds, enter "0.25". No data file will be imported if the observation time is less than the value specified in this field.
Valid antenna height range From... To...	Lower and upper limits of the antenna height from the ground. Enter these values in the selected unit. Any antenna value outside this range is considered a blunder and displays with a warning.

- **Network Adjustment**. GNSS Solutions allows you to weight the network adjustment results. The **Confidence scaling factor** field can be used for this purpose. Unless you are familiar with this parameter, keep it unchanged (default value: 1). See also *Chapter 6: Adjustment on page 109*.

- **Quality Control**:

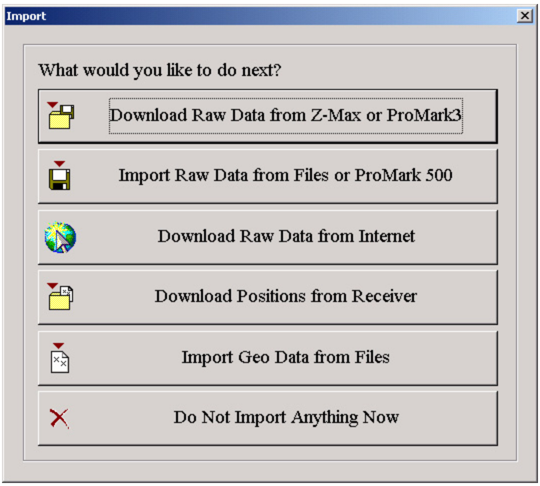
Horizontal	Use this field to enter the desired horizontal accuracy for all vectors processed and adjusted in the project. Computed uncertainties of adjusted data will be compared to this threshold value. Any data not meeting this accuracy will be flagged in the QA attribute as Failed.
Vertical	Use this field to enter the desired vertical accuracy for all vectors processed and adjusted in the project. Computed uncertainties of adjusted data will be compared to this threshold value. Any data not meeting this accuracy will be flagged in the QA attribute as Failed.
Maximum acceptable control error	Use this field to enter the maximum permitted deviation between the known coordinates of any control, target or reference point and the surveyed coordinates for this point.

- **Satellites**: Select the satellite systems you wish to use in your project (GPS,GLONASS, SBAS). Any combination is possible.
- **VRS Max. Range**: In the VRS process, this parameter is used to limit the number of usable stations to only those located at a distance from the survey point less than this value. All reference stations located beyond this distance will not appear in the list of usable stations. Default value: 200 km (125 miles). See also *VRS Data Processing on page 231*.

- **Processing scenario control** (**Rebuild process scenario automatically on any change** parameter). If you make changes to the project that impact the processing scenario determined by the program, GNSS Solutions will refer to this parameter to know how to respond. If the button is checked, the processing scenario will be updated automatically. If the button is cleared, GNSS Solutions will prompt you to update the scenario, which you can accept or reject.

(**Feature Code List** tab: See *Editing the Feature Code List on page 162*.)

6. At this point you have finished setting up the project, but the project contains no raw data to process; you must now add raw data to the project. Click **OK** to close the **Default Project Settings** dialog and **OK** again to close the **New** dialog. The **Import** dialog appears (see below). For information on adding data files to your project, refer to *Chapter 4: Adding Data Files to a Project on page 49*.

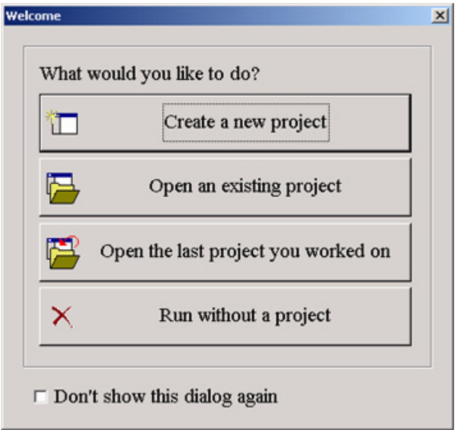


Opening an Existing Project

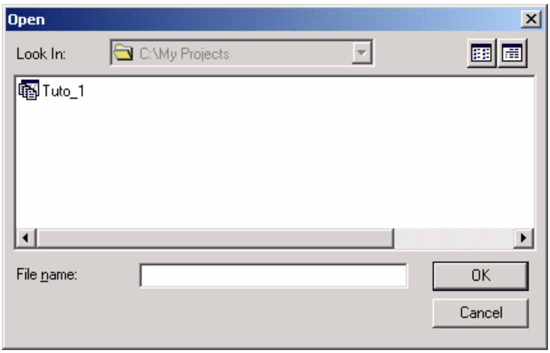
You can open an existing project at startup or any time the software is running.

To open a previously created project at start up:

1. In the Welcome dialog, click on **Open an Existing Project**.



2. In the **Open** dialog that opens, navigate to the filename of the project you wish to open:



3. Double-click the filename or highlight the filename and click **OK**. The project opens with the Time View/Survey View and Workbook windows. GNSS Solutions displays the project name in the title bar.

Projects

To open a project with GNSS Solutions running:

- Click the **Open** button on the toolbar, or
- Select **Open** from the **File** menu, or
- Click the **Project** topic bar in the Command pane and then click on the **Open Existing Project** icon.
  This closes the open project and opens the **Open** dialog. Then proceed as explained in steps 2 and 3 above.

After opening a project, you may need to add data files. To add files, refer to *Chapter 4: Adding Data Files to a Project on page 49*.

Saving a Project

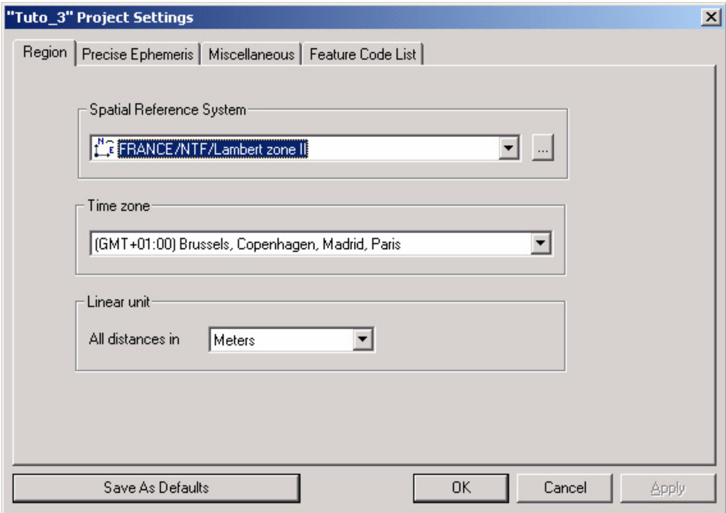
You can save an open project at any time with one of the following methods:

- Type Ctrl+S
- Click the **Save** button on the toolbar
- Select **Save** from the **File** menu

You can also save the current project under a different name by selecting **Save As** from the **File** menu. The **Save As** function is not a *Rename* function. What this function actually does is it duplicates the current project, names it as instructed, closes the current project and opens the newly created project in the main window.

Project Settings

The project settings are either the default values or were set when the project was created. To view project settings, select **Project>Edit Settings**. The **Project Settings** dialog appears, as shown below.

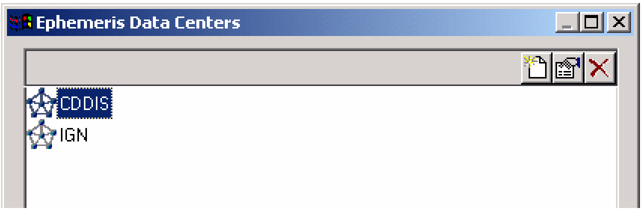


The Project Settings dialog lets you set the same parameters as the **New Project** dialog. You can edit any of the parameters within the **Region** and **Miscellaneous** tabs.

Once you have modified the parameters, click **OK** to save the project settings and close the dialog.

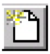
Adding an Ephemeris Data Center

- From the menu bar, select **Tools>Ephemeris Data Centers**. This opens a new dialog box showing the default data centers.

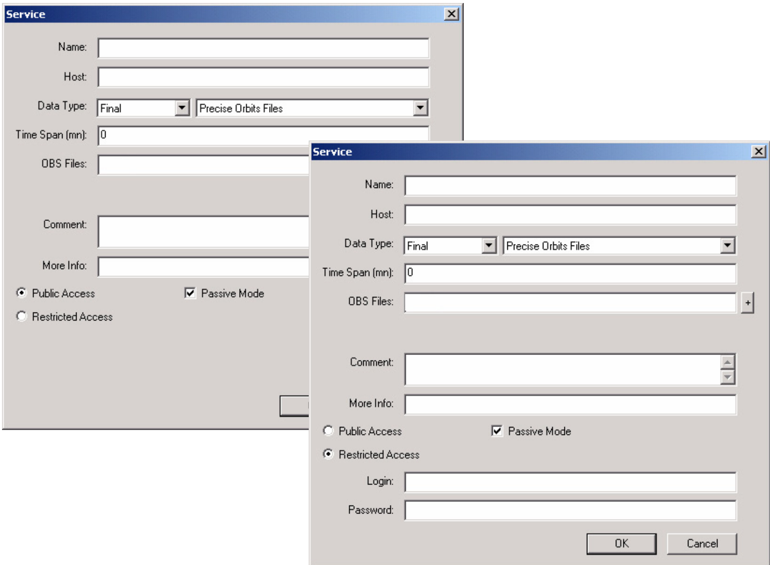


- Click on  in the upper-right corner of the Ephemeris Data Centers window. This opens a two-tab Properties dialog box.
- Click on the **Description** tab and then enter the following parameters:
  - **Name**: Data center name (mandatory)
  - **Comment**: More information about the data center (optional)
  - **Info**: Web site giving more information on this data center (optional)

- Click on the **Services** tab.

- Click on  in the upper-right corner of the window. This opens the Service dialog box.

Note that this dialog box will be slightly different depending on whether the access to the web site is public or restricted.



This dialog box is organized, and should therefore be used, as follows:

- **Name**: Enter the service name or any other information relevant to the desired service. For example enter "Precise ephemeris data"
- **Host**: Enter the web address from which to download
- **Data Type**: Choose the type of data delivered by this service. The choice refers to both rate (Final/Rapid/Ultra-Rapid) and type (Precise orbit files/ Precise clock files/Precise ionospheric data files).
- **Time Span**: GNSS Solutions needs to know the period of time covered by any of the files delivered by this service. Enter this time in minutes. Ask the data center or consult its web site if you do not know this value.

Projects

- **OBS Files**: GNSS Solutions needs to know where the files are stored on the data center's web site and how they are named. You should then enter the path to files followed by the syntax used in the filenames. The "+" button located on the right of this field allows you enter this syntax in a more friendly way. Note that you can use [SSSS] to specify a wild string.
  Ask your data center or consult its web site if you do not know the path and the syntax of filenames.
- **Comment**: Enter your personal notes regarding the service (optional)
- **More Info**: For example, use this field to enter the address of a particular page on the data center's web site.
- **Passive mode**: Enable this option to bypass your local firewall.
- **Public/Restricted Access** radio buttons: Choose the appropriate option. If you check **Restricted Access**, then you will have to enter a user name and a password in the next two fields.
- **Log in**: If you have checked **Restricted Access**, enter the user name normally supplied by the provider to access the specified web site
- **Password**: If you have checked **Restricted Access**, enter the password normally supplied by the provider to access the specified web site.

- Click **OK** to save the service you have just defined. This closes the dialog box and takes you back to the previous dialog box where you can see the list of existing services defined for this data center.

- To create a new service, click  again and resume the above instructions.
- Click **OK** when all the services have been defined. This takes you back to the Ephemeris Data Centers window where the new data center is now listed. ❑

Chapter 4: Adding Data Files to a Project

This chapter describes the process for adding data files to a project. This process uses the Download and Internet Download modules of GNSS Solutions. The following tasks are described:

- Downloading Data From a Receiver
- Importing Data from Files
- Downloading Base Data from the Internet
- Importing Positions, Vectors or Features From Files

Downloading Data From Z-Max or ProMark3

The data logged on the data card or receiver memory during your field surveys can be downloaded into a GNSS Solutions project via the Download utility program using the **Project>Download Raw Data from Z-Max or ProMark3** command in GNSS Solutions.

Warning! Atom raw data (G*.* files) cannot be downloaded using this command. Only the **Project>Import Raw Data from Files or ProMark 500** can be used to download Atom raw data (see *Importing Data from Files or ProMark 500 on page 51*).

Downloading data from a receiver can generally be performed according to one of the following two methods:

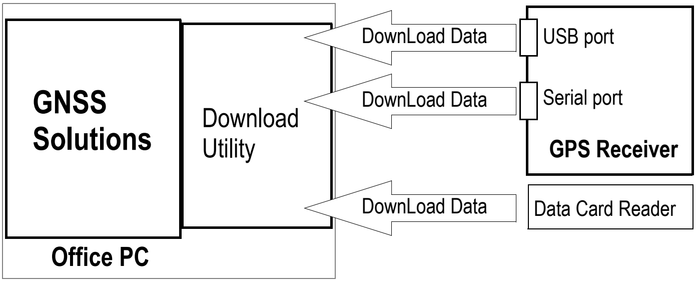
- Via the USB port
- Via serial port

It is recommended to use the USB port rather than a serial port as this connection offers a faster transmission speed (up to 50 kB/s for USB, only 10 kB/s for a serial port).

Adding Data

A third method also exists in which you have to remove the data card from the receiver and insert it into the card reader installed in or connected to your PC. This method is the fastest one as the data is routed directly from the data card to the Download module, but you need the appropriate card reader.

The diagram below summarizes the three download methods.



To download data from the card installed in the receiver, do the following:

- Power on the receiver and connect it to the Office PC via USB port
- On the GNSS Solutions menu bar, select **Project>Download Raw Data from Z-Max or ProMark3**. This starts the Download utility program and opens its main window on the screen.
- On the menu bar in Download, select **File>Connect>Receiver>Connect via USB**, then choose Thales Navigation USB device# in the **Connect via USB** dialog box that opens, and finally click **OK.** After communication is established with the receiver, Download shows the files in the PC current directory on the right pane, and the files present in the data card on the left pane
- On PC side, select the directory where you want to download the files (default directory: project directory)
- On the left pane, select the file(s) to be downloaded and drag them to the PC pane. Download copies the file to the PC. A progress dialog box indicates the status of the download.

  The **Project>Download Raw Data from Z-Max or ProMark3** *command should not be confused with the* **Project>Import Raw Data from Files or ProMark 500** *command. The latter command can only import pre-converted data files, ready for processing, whereas the former command, in which the Download module is involved, is used to download AND convert the raw data files that come direct from the field and that Download splits up into several files for GNSS Solutions to process them.*

Importing Data from Files or ProMark 500

This is a **key function** in GNSS Solutions as not only does it allow you to add data to your projects but also to do the following:

- Before importing the data to the project:
  1. Check/edit the Site IDs associated with the observation files you are importing
  2. Check/edit the file type (fully dynamic or static, with or without static occupations)
  3. Check edit the antenna characteristics (antenna type, height and height type)
  4. Display the time view giving the relationship between all the observation files selected for import
  5. For each observation file selected for import, plot the S/N ratio, elevation and carrier phase for each satellite received during this observation
  6. Set control points and possibly fix some of them.
- Rather than running the *Import Data* function alone, you can ask GNSS Solutions to automatically run one or more functions after this one – this is one of the most outstanding features in GNSS Solutions. Here are the different possibilities:
  1. *Import*: you just want to add data to the project. You will run the processing later on.
  2. *Import and process single sites*: In addition to importing data, GNSS Solutions will also compute –in autonomous GPS mode– the locations of the points associated with the observation files.

3. *Import and process baselines*: you want GNSS Solutions to automatically process the data once imported in the project.
4. *Import, process and adjust*: Same as previously except that in addition, GNSS Solutions will then adjust the vectors based on the control points you will have set and fixed before importing the data.

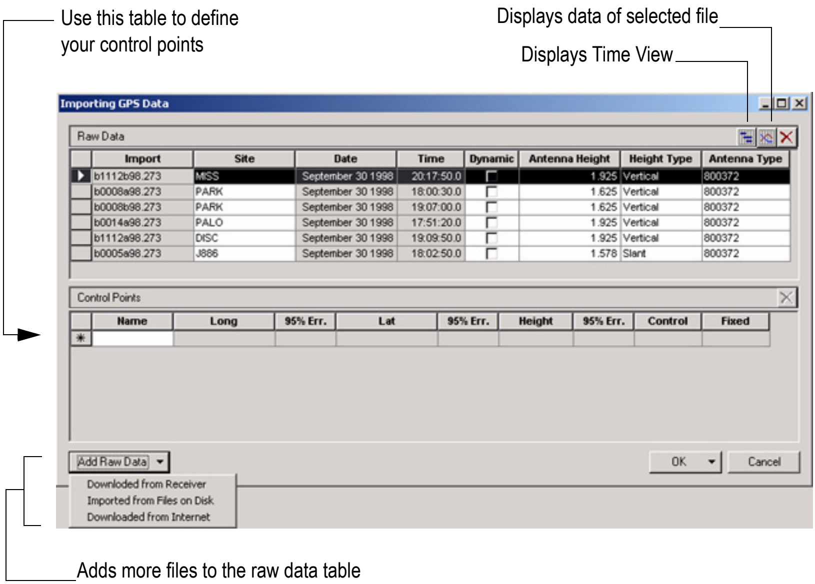
Follow the instructions below to use the Import Data command:

- Press **F4** or select **Project>Import Raw Data from Files or ProMark 500**. If you want to import raw data directly from a ProMark 500, connect this unit to your office computer via a USB cable.
- Choose the type of data you want to import. The table below summarizes all the input formats supported by GNSS Solutions.

Import Format
Atom (G*.*)
Ashtech (B*.* file)
RINEX (*.*o or *.*d file)
DSNP (*.bin, *.var or *.d* file)

- Browse on your disk to select the folder containing the files to import and then select these files. If you are importing raw data directly from a ProMark 500, browse this unit, seen as a USB device, and then select the desired raw data files.
- Click the **Open** button. This opens the **Importing GPS Data** dialog box.

This dialog (see example below) is *one of the key dialog boxes* in GNSS Solutions for post-processing applications as it gives you full view upon, and full control over what's going to be post-processed and how.



The upper table allows you to read the properties of the files selected for import.

- Check and, if necessary, edit the following parameters:
  1. Name of point (site) associated with observation file
  2. File type (Dynamic/static). GNSS Solutions automatically detects the type of the file. (The box is cleared if the file is static.)
  3. Antenna height value

4. Height type. Tells GNSS Solutions how you measured the antenna height (through a vertical, true or slant measurement)
5. Antenna type. If the mentioned antenna type is unknown to GNSS Solutions, it will appear in bold characters in the field. This means you will have to define its properties when you import the file (a dialog will appear at that time so you can enter these properties).

   If the field is blank, this means the file does not mention the type of antenna that was used in the field. You must now specify this antenna type by selecting this type from the list of known antennas. If necessary, ask the field operator if you don't know the type of antenna that was used. If it turns out that the antenna used is unknown to GNSS Solutions, you must first create this antenna type (see *Creating a New Antenna Type on page 88*).

- Three buttons in the upper right corner are associated with this table:

  : Displays a time diagram showing the static occupations detected in the files listed in the upper table. Static occupations are represented by gray rectangles and dynamic occupations by gray lines. If you click on this button after selecting one of the files in the table, then the static occupation corresponding to this file will appear in dark blue. See also *Observation Properties on page 67*.

  : Displays a time diagram showing the data for each satellite, as read from the selected file. See also *Observation Properties on page 67*.

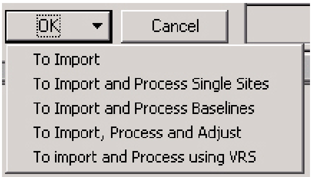
  : Allows you to remove the selected file from the table because you do not want to import it anymore.

- **If you wish, you can right now set control points, i.e. BEFORE importing the files** using the table at the bottom of the dialog. You can still set and fix control points after importing data files (see *Chapter 5: Data Processing*).

  Control points can only be points derived from the files present in the upper table. After you select a point in the first cell (**Name** cell), press the **Tab** key to edit the properties of the control point. These properties are derived from the corresponding data file. You can edit these properties. For example you can:
  - Change its coordinates if you know the true values of some or all of its coordinates
  - Define its type, i.e. which of the coordinates are accurately known (hence 1D, 2D or 3D). In the **Control** cell, select “Ver.” for 1D, “Hor.” for 2D and “Hor.&Ver.” for 3D.
  - “Fix” some of its coordinates, i.e. force GNSS Solutions to keep the coordinates you supply for this point rather than allow it to determine these coordinates through post-processing. At this stage, you usually fix only one of the points that you set as control points. In the **Fixed** cell, select “blank” to not fix the control point, “Hor.” to fix it horizontally (Lat/Lon or X/Y), “Ver.” to fix it vertically (Elev./Height) or “Hor.&Ver.” to fix all its coordinates.

The **Add Raw Data** button allows you to add more files to the upper table without having to resume the whole file import process. Files may have different sources (your disk, Internet or your field equipment). See *Downloading Base Data from the Internet on page 58* to learn how to download data from the Internet.

- When you are ready to import files, click on the **OK** button. A drop-down menu is displayed in which you can choose to simply import the files or automatically run one or more operations in succession after file import:



- Choose the option that suits you best:

- Use **To Import** if you just want to import the files. You may want to do this because you prefer to break down the whole processing into distinct basic steps. Why? Because you want full control over each of these steps. You will then analyze the processing scenario prompted by GNSS Solutions and make changes to it if required. You will then run the baseline processing as such followed by a network adjustment step, if appropriate.
- If you use the **To Import and Process Single Sites** option, GNSS Solutions will import the files and then will determine the locations of all the points calculated from the imported files. Use this option to preview all the points of a dynamic or stop & go survey prior to processing the baselines.
- Use **To Import and process Baselines** to import and then process the baselines according to the processing scenario found by GNSS Solutions. You will skip the checking of the processing scenario when you choose this option.

- Use **To Import, Process and Adjust** if you want to obtain the results in the fastest possible manner. This implies however that you entirely rely on GNSS Solutions in the choices of the processing options since you will not be able to check the processing scenario or analyze the results before network adjustment. You will however be able to thoroughly check all the results once they are made available on the screen.
- VUse **To Import and Process Using VRS** if you want to post-process your field data using the VRS base raw data file you have asked GNSS Solutions to generate rather than the base raw data from a given base. See also *VRS Data Processing on page 231*.

Suggestions & Recommendations:

- Choose **To Import, Process and Adjust** only if the project contains redundant measurements.
- If you are working on geodetic networks, you should NOT fix more than one control point at this stage as it is essential that you start with a minimally constrained adjustment before proceeding to a fully constrained adjustment.

Downloading Base Data from the Internet

Base data can easily and rapidly be downloaded from the web using the **Internet Download** utility.

You need to use this functionality when you do not have your own equipment to collect the base raw data you need for post-processing your field data. You need base raw data for a given period of time corresponding to the time when you were working in the field with your survey equipment.

You will preferably download raw data from the available base station the closest to your working area. If this station is shown on the Survey View, a new automatic procedure now available in GNSS Solutions lets you download raw data from this station through a few clicks of the mouse (see *Downloading Data From a Reference Station Shown on the Survey View on page 60*).

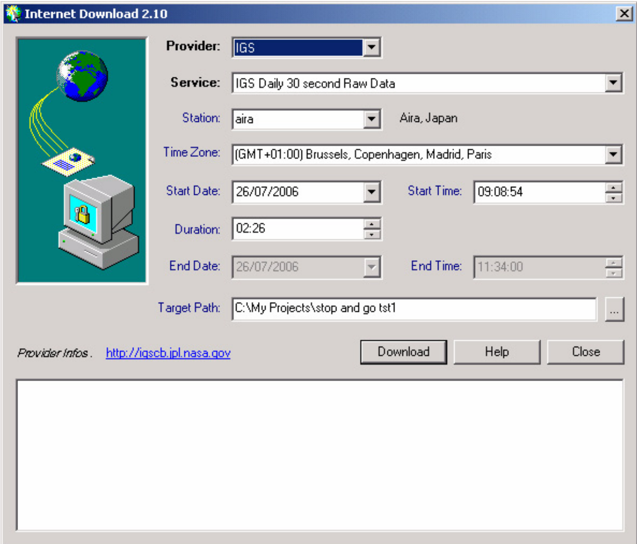
Remember that for a reference station to be visible on the Survey View, it must have been added to GNSS Solutions by creating a new provider (see *Adding a New Provider on page 221*).

In all cases, the recommended order to add data to your project is first you import or download the rover data and then you download base raw data. If you operate in this order, you will automatically set the date & time parameters in Internet Download to be consistent with the date & time of the rover data.

❑ General Case

You can invoke the Internet Download utility either separately from the Windows task bar or from the **Importing GPS Data** dialog (see *Importing Data from Files on page 51*) when you are adding data to the open project from files on your PC disk. In this dialog, click on the **Add Raw Data** button located at the bottom of the dialog and then select **Downloaded from Internet**.

This opens the Internet Download main window:



Follow the instructions below to use Internet Download:

- In the **Provider** field, choose the name of the provider Internet Download will have to connect to to get the required data. For your information, when selecting a provider in this field, its web address appears at the bottom of the window.
- In the **Service** field, choose the type of data you want to download from the provider.
- In the **Station** field, choose the station from which you want data.
- In the **Time Zone** field, choose the time zone relevant to your working area.
  Note that the **Start Date** and **Start Time** fields are automatically set to cover the period of time defined by the observation files already present in the open project (or about to be added to the project). You may however change these settings if required.

- In the **Target Path** field, enter the path and folder on your PC where you want Internet Download to store the downloaded files.
- Click the **Download** button to start downloading the files. This may take a while. Messages will appear at the bottom of the window to keep you informed on the operations in progress.
- When downloading is complete, click on the **Close** button to close the Internet Download window and return to the **Importing GPS Data** dialog.

❑ Downloading Data From a Reference Station Shown on the Survey View

You can go even more quickly to acquire the required base raw data by downloading them from the reference station icon shown on the Survey View:

- In the map toolbar, click on .
- In the Survey View, double-click on the icon of the reference station from which you wish to download data. This opens a dialog box showing the properties of the station.
- Click on the **Download Data** button. This launches the Internet Download utility. Note that the now non-editable **Provider** and **Station** fields have automatically been preset to match those of the station.
- Choose the type of data you want to download from this station (**Service** field). If you choose one of the possible three orbit data types, the **Station** field will disappear from the dialog box.
- Enter the date, time and duration for which you want base data.
- Click on the **Download** button to start downloading the data. At the end of the sequence, "**Process completed successfully**" appears in green at the bottom of the Internet Download window. The downloaded files can be found in the project folder.
- Click the **OK** button to close Internet Download.

Importing Positions, Vectors or Features From Files

- In the Command pane, click on the **Import** topic bar and then on the **Import Geo Data from Files** icon.
- Choose the type of data you want to import and then click **OK**. The table below summarizes all the input formats supported by GNSS Solutions versus the type of imported data.

Import Format	Points	Vectors	Features*
NMEA (*.txt file)	✓		
TDS (*.CR5 file)	✓		
Carlson (*.CRD file)	✓		
User-defined	✓	✓	
Ashtech (O*.* file)		✓	
AutoCAD (*.DXF file)			✓

: Available only if* **Show CAD functions *option is enabled in* **Tools>Preferences**.

For more information on the user-defined format, *see Creating Custom Formats on page 154.*

- Browse on your disk to select the folder containing the files to import and then select these files.
- Click the **Open** button. GNSS Solutions then imports the data contained in the chosen file(s) into the open project. A message in the Output pane indicates the end of data import. The imported data can be seen in the Survey View and the Workbook window.

Deleting a Data File from a Project

Any raw GPS data file loaded into a project can later be deleted from the project. Be aware that vectors generated by these observations will NOT be removed automatically from the project.

To delete data files:

- Switch to the **Files** tab in the Workbook window.
- Select the row containing the file name of the files you wish to delete (click in the leftmost cell to select the entire row)
- Press the **Delete** key. A confirmation message appears
- Confirm that you want to delete the file by clicking on the **Yes** button.

After deleting a data file, you must add the data file to the project again in order to use it.

Deleting a Point from a Project

Deleting a point from a project causes all vectors based on this point to be deleted as well.

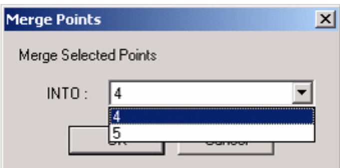
- Select the point in the Points tab of the Workbook window.
- Press the **Delete** key on your keyboard.

Merging Two Points

You may need to merge two points together because they are in fact the same point. You usually need to do that to clean the data coming from the field where, for any reason, a number of additional points were unnecessarily created.

To merge two points into a single one:

- Select the two points on the Survey View
- From the menu bar, select **Project>Merge Points**. A message will appear informing you of the distance between these two points and asking you whether you really want to merge these two points.
- Click **Yes**. A new window is displayed asking you to specify which of the two points is the real one. This point is the point that will continue to exist after the merge operation.



- Choose this point from the list and then click **OK**. The two points are then merged into a single one.

Merging two points is different from deleting the unwanted point in that it preserves all the baselines connected to the unwanted point. These baselines are then all attached to the remaining (real) point.

You cannot merge more than 2 points at a time. ❑

Chapter 5: Data Processing

Raw data collected by a receiver must be processed to determine the differential relationship between the points occupied during data collection. The result of processing GPS raw data is a vector defining this relationship. Computation of these vectors is the role of the data processing module within GNSS Solutions.

The data processing module automatically analyzes the quality of the raw data files and adjusts processing parameters to produce the best vector possible, transferring most of the processing effort from the user to the processing software. In GNSS Solutions, the actual processing of your data is limited to a simple press of the Process button, safe in the knowledge that you will get the best answer.

GNSS data is processed in three steps:

- **Pre-process data analysis**: Point and observation properties, such as Site IDs, antenna height parameters, and control point information are verified and/or entered. As explained in *Chapter 4: Adding Data Files to a Project*, this step can be run BEFORE importing data files into a project.
- **Processing**: A push of a button invokes the processing engine to produce GNSS vectors from raw data.
- **Post-process data analysis**: Processed GNSS vectors are analyzed using supplied analysis tools, to determine the quality of processed data.

This chapter outlines the steps for processing your raw GNSS data.

Pre-Processing Analysis: Editing Data

The processing of GNSS vectors relies on two sources of data, raw GNSS data collected by the receiver, and observation and point-specific data provided by the user. When using a handheld or a GNSS receiver with an integrated user interface, much of the user-supplied data can be entered in the field during data collection. In this case, verify the data before processing. If a handheld was not used, this data must be entered manually.

Verification and editing of user-supplied observation and point data can be performed in more than one location within GNSS Solutions. Primarily, the Observation Property dialog is used for this task. The next section in this chapter outlines the user-supplied data that can be viewed and edited in this dialog.

You should analyze your data before processing. Pre-processing data helps you through the preparation of data for baseline processing. You will also be able to identify and correct common problems.

To begin the pre-process analysis:

- If you have not done so already, load all the data files into your project. See *Chapter 4: Adding Data Files to a Project* for more information.
- Verify that the Time View window and the Workbook window with the **Files** tab are open.

If you logged point information in the field using a handheld or integrated user-interface on the receiver and have confirmed that Site IDs, observation time, and antenna heights are correct, then you may not need to edit your data.

However, when viewing the data during the preprocess analysis, you may find that you need to change some values. For example, if you conducted a static survey without entering point information, you need to set the Site IDs and antenna heights for every observation, or edit a point name entered incorrectly on the handheld.

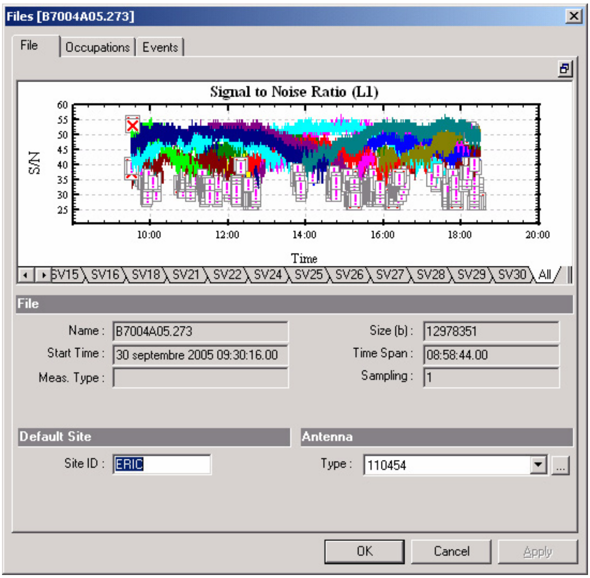
❑ Observation Properties

User-supplied observation data consists of the observation Site ID and antenna height parameters. If this information was entered in the field using a hand-held or integrated user-interface to the receiver, verify the information is correct. If this point information was not entered in the field, it needs to be entered manually prior to processing.

You can view the properties of each observation by selecting the **Files** tab in the Workbook window and double-clicking the leftmost cell of the row corresponding to this observation. You can also double-click the filename in the Survey view.

The observation properties are presented on three tabs, the **File**, **Occupations** and **Events** tabs.

1. The **File** tab contains the following information:



Data Processing

- Graphic area on top showing Signal-To-Noise Ratio, Satellite Elevation or Carrier Phase versus Time. This information can be plotted for each satellite, or for all satellites in view during the observation by clicking the corresponding tab in the lower part of the graphic area.

  Clicking  in the right-upper corner will maximize the graphic area on the PC screen for maximum reading comfort. You can zoom in on a particular region by dragging a rectangle around this region. Press the **Esc** key to zoom out.

  Flags will be shown on the curves wherever something happened during data collection: loss of lock (X), possible loss of lock (!), carrier phase questionable (?). To read the meaning of a flag, simply click on this flag.

  Markers can also be shown on the curves. They represent the time of basic data acquisition from a given satellite.

  Selecting the desired viewing options for the graphic area is achieved by right clicking anywhere in this area and making the desired choices on the pop-up menu.

  The following characteristics of problem satellite data can cause poor results when processed:

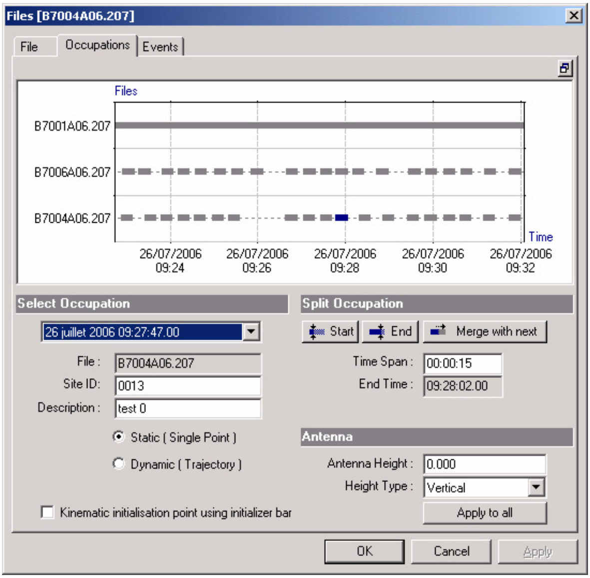
  - Segments of satellite data that contain multiple flags. This is characteristic of an obstructed satellite.
  - Gaps in the data caused by extended loss of lock of the satellite. This is characteristic of an obstructed satellite.
  - A satellite with rapidly varying signal-to-noise ratio compared to other satellites. This is characteristic of a satellite affected by multipath or an active ionosphere.

- A segment of a satellite with rapidly varying signal-to-noise ratio compared to the rest of the same satellite data. This is characteristic of a segment of a satellite affected by multipath or an active ionosphere.
- A satellite contributing a very small amount of data compared to the other satellites in the data set. Sometimes such a satellite causes problems with processing.

  For all these reasons, it is highly recommended to mask or delete this data before running the process.

- **File** pane: Shows non-editable parameters describing the observation (filename, GPS time at the beginning of the observation, measurement type, file size in bytes, observation duration, recording rate -sampling- in seconds)
- **Default Site** pane: Shows the name (ID) given by the operator to the point associated with the file. If the operator forgot to name the point, GNSS Solutions will name the point using the name of the observation file.
- **Antenna** pane: Shows the antenna type used during the observation, as read from the observation file, or as specified previously when importing the file (see page 54). A button next to the field allows you to view the physical properties of this antenna.

2. The **Occupations** tab contains the following information:



- Graphic area on top showing ALL the observation files present in the project. For more information about the graphic conventions used, refer to *Using the Time View Window on page 29*. The dark-blue occupation represents the currently selected occupation in the **Time** pane (see below).

  Clicking  in the right-upper corner will maximize the graphic area on the PC screen for maximum reading comfort. Using the pop-up menu, that you can have access to by right-clicking anywhere on the graphic area, you can zoom in or out on the diagram. Once you have zoomed in several times, you can also browse the diagram horizontally using the **Panoramic** command, also available from the pop-up menu.

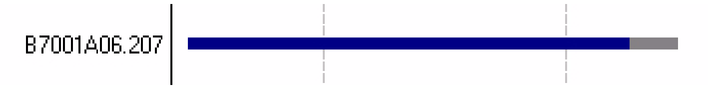
- **Select Occupation** pane:
  - Select Occupation combo box: Identifies the currently selected occupation (date and start time). Also allows you to select another occupation in the same observation file (will cause the selection to move to the corresponding line or bar on the graphic area).
  - **File**: Observation filename (non-editable).
  - **Site ID**: Site ID associated with the selected occupation. This field is normally completed by the field operator. It can be:
    - A 4- to 9-character string representing the Site ID associated with the selected static or kinematic occupation.
    - Or a blank field if the occupation is an excluded one.

    You can edit this field either to modify the Site ID chosen by the field operator or to change the nature of the occupation:
    - Clearing the field will cause the occupation to become an excluded one (and the **Static/Dynamic** choice will be made invalid).
    - Conversely, entering a four-character string if the field is initially blank will transform the occupation into a static or kinematic occupation, depending on whether you select Static or Dynamic (see below).

    In any case, changing this parameter will cause GNSS Solutions to update the processing scenario when you click **OK** to close the dialog.
  - **Description**: Description of the site (editable; 31 characters max.)
  - **Static/Dynamic** choice: Valid only when the Site ID field contains at least 4 characters. This choice is normally software-set on importing the observation file. You can however change it at your convenience.
  - **Kinematic initialisation using initializer bar** check box: When checked, indicates that initialization was performed with the rover antenna placed at the end of the base's initializer bar (for OTF initialization or initialization at a known point, it's cleared). This is analyzed by GNSS Solutions when importing rover files. The check box is then set accordingly. You are not supposed to change this setting. There will be no impact on the processing if you clear this check box that GNSS Solutions checked on. On the other hand, you will introduce an error in the processing if you check on the box that GNSS Solutions cleared.

- **Split Occupation** pane:
  See also *Filtering Occupations on page 75* for more information on how to use the Split function.
  - **Start**: Click this button to split the selected occupation into two distinct occupations of the same nature. The resulting first occupation represents about 10% of the initial occupation and the second one, about 90%. On splitting the occupation, GNSS Solutions automatically selects the first (shorter) occupation (shown in dark blue on the time chart below). The exact duration of the selected occupation (and hence of the second) can be set by editing the **Time Span** field.

  - **End**: Click this button to split the selected occupation into two distinct occupations of the same nature: The resulting first occupation represents about 90% of the initial occupation and the second one, about 10%. On splitting the occupation, GNSS Solutions automatically selects the first (longer) occupation. The exact duration of the selected occupation (and hence of the second) can be set by editing the **Time Span** field.



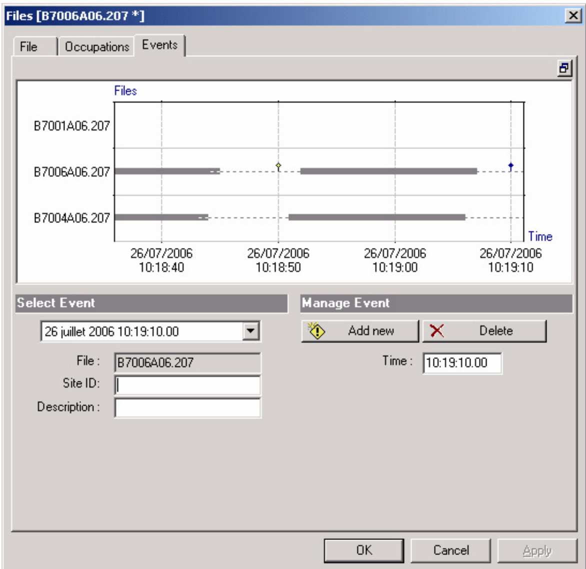
  - **Merge with Next** button: Allows you to merge the selected occupation with the next one. The resulting occupation is of the same nature as the occupation you initially selected.
  - **Time Span**: Indicates the duration of the selected occupation (editable). Changing this parameter always affects the end time, not the start time, of the occupation. Consequently, it also affects the start time of the next occupation.

To validate the new value assigned to this field without closing the dialog, you just have to click inside another field in the dialog.

- **End Time**: Indicates the end of the selected occupation, taking into account the **Time Span** setting.

- **Antenna** pane:
  - **Antenna height**: Antenna height for the selected occupation.
  - **Height Type**: Type of measurement used to measure the antenna height (slant, vertical, true) for the selected occupation.
  - **Apply to All** button: Click this button to apply the two antenna parameters to all the occupations in the observation file. Caution! This cannot be undone.

3. The **Events** tab contains the following information (for more information about events -what they are for, how they are processed- please refer to *Processing Events on page 94*):



- Graphic area on top showing the events from ALL the observation files present in the project. The dark-blue event represents the currently selected event in the **Select Event** pane below.
- **Select Event** pane:
  - Select Event combo box: Identifies the currently selected event (date and time). Also allows you to select another event in the same observation file (will cause the selection to move to the corresponding event in the graphic area)
  - **File**: Name of the observation file containing the selected event.
  - **Site ID**: Name of the selected event (9 characters max.). If you are creating a new event, this field is blank and so you have to enter a name for the new event. If the selected event was imported from the observation file, the event already has a name: you may change it or not.
  - **Description**: Additional information about the selected event (31 characters max.)
- **Manage Event** pane:
  - **Add new** button: Allows you to create a new event in the observation file mentioned in **File**.
  - **Delete** button: Allows you to delete the selected event.
  - **Time**: Allows you to set the time of occurrence of an event you are creating or change the time of occurrence of the selected event. To see where GNSS Solutions places the event on the time chart (graphic area on top of the dialog) once you have set the time, click inside another field in this dialog (this action is equivalent to validating the value typed in the **Time** field).

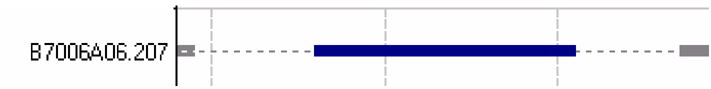
❑ Filtering Occupations

Filtering occupations is the process through which GNSS Solutions can reject unwanted parts in an observation file from the processing. Unwanted parts may be periods of time during which GNSS reception was poor or field operations were questionable or useless, etc.

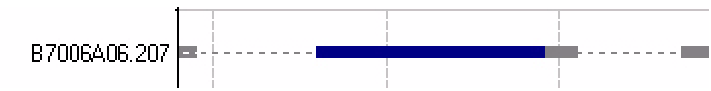
Filtering occupations in GNSS Solutions is mainly obtained using the split function, as introduced on *page 72*, combined with appropriate settings for the **Site ID** and **Time Span** fields. It should be noted that splitting an occupation in no way affects the previous and next occupations in the observation file.

As an example, the split function allows you to crop the two ends of a static occupation in a Stop & Go survey, for example in order to make sure the occupation is truly static from start to end. Here is how you can do this.

1. In the project, click on the Time View tab
2. On the Time view, use the Zoom In and Grabber commands to locate the occupation that needs cropping and then double-click this occupation.
3. On the top diagram in the Files properties window, use the context-sensitive menu (Zoom In, Zoom Out, Panoramic commands) to optimize the view of the selected occupation.

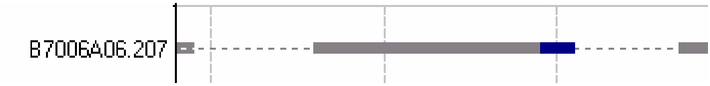


4. Click the **End** button. This splits the occupation into two occupations. If necessary, adjust the **Time Span** value for the selected occupation, then click inside another field in the dialog to validate the new time span value.

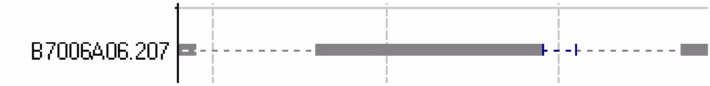


Data Processing

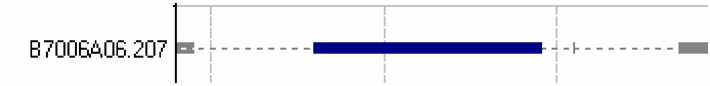
5. From the combo box in the Select Occupation pane, select the shorter occupation resulting from the splitting. As the combo box remembers the currently selected selection, you just have to select the next occupation in the list.



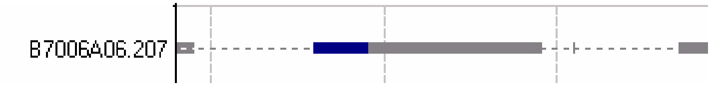
6. Clear the **Site ID** field for this occupation. As a result, the occupation changes nature to become an excluded occupation.



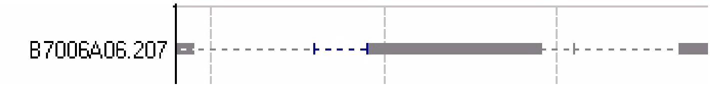
7. From the combo box in the Select Occupation pane, select the longer occupation resulting from the splitting (i.e. the previous one in the list).



8. Click the **Start** button. This splits the occupation again into two occupations. If necessary, adjust the **Time Span** value for the selected occupation, then click inside another field in the dialog to validate this new value.



9. Clear the **Site ID** field for the selected occupation. As a result, the occupation changes nature to become an excluded occupation. The two ends of the static occupation have now been cropped to the desired values:



10. Click **OK** to close the File properties window and validate all the changes made.

This is just an example of what can be done with the Split function, combined with the use of the **Site ID** and **Time Span** fields, to filter your occupations. There are a lot of other cases of use. For example, you can remove sections of a trajectory or transform a kinematic occupation into a static occupation, etc.

❑ Point Properties

User-supplied site data consist of Site ID, site descriptor, and, if available, known site coordinates. If any sites occupied during data collection have known coordinates, these should be entered as control sites for processing, for you should begin processing with known coordinates at a minimum of one site. This is referred to as the seed site for processing.

GNSS Solutions can process raw data without a seed site. In such a case, GNSS Solutions selects one site to use as the control for processing. The raw data coordinates for this site are used as the seed coordinates. In some cases this may introduce error in the processed vectors in the amount of approximately 2-4 ppm of vector length. If this level of error is significant to your survey, you should use a control site to process the data. The following message is issued in the output pane when the processing is run without a control point:

```
Warning: process starts from an approximated base station position...
```

Kinematic data needs special attention when preparing the data for processing. If the kinematic survey was initialized on a known vector, i.e. two known sites, the coordinates for the sites on each end of this vector must be entered as control sites. If initialization was performed using a Kinematic Initialization bar, the base site should be identified as a control site. If this site does not have known coordinates, use the raw data coordinates.

You can view the properties of each point by selecting the **Points** tab in the Workbook window and double-clicking the leftmost cell of the row corresponding to this point. You can also double-click the point name in the Survey view.

Fundamentally, GNSS Solutions handles 5 point types:

- Logged point: Point surveyed in the field in real-time or post-processing mode
- Intermediate point: Logged point of lesser interest (e.g. a point in a trajectory)
- Control point: Surveyed point whose accurate position is already known. This known position can be set as a fixed input to the processing or simply used as comparison material to assess the quality of the survey:

  Control point (not fixed)

  Control point fixed vertically

  Control point fixed horizontally

  Control point fixed vertically and horizontally
- Reference point: A point materialized in the field whose theoretical coordinates are known in the local system and that will be surveyed for calibration purposes.
- Target point: A point whose theoretical coordinates, known in the local system, are provided for staking-out purposes

The table below summarizes the different icons used in GNSS Solutions to represent these point types. Additional information is also provided about their coordinates and error reports.

Icon	Type	Control Coordinates Expressed on	Survey Coordinates Expressed on	Error Report (1)
	Logged point	NA	Project's system	NA
	Intermediate point	NA	Project's system	NA
	Control point	Project's system	Project's system	Yes
	Reference point before survey	Local system	NA	NA
	Reference point after survey		Project's system	Yes (2)
	Target point before survey	Local system	NA	NA
	Target point after survey		Project's system	Yes (2)

NA=Not Applicable

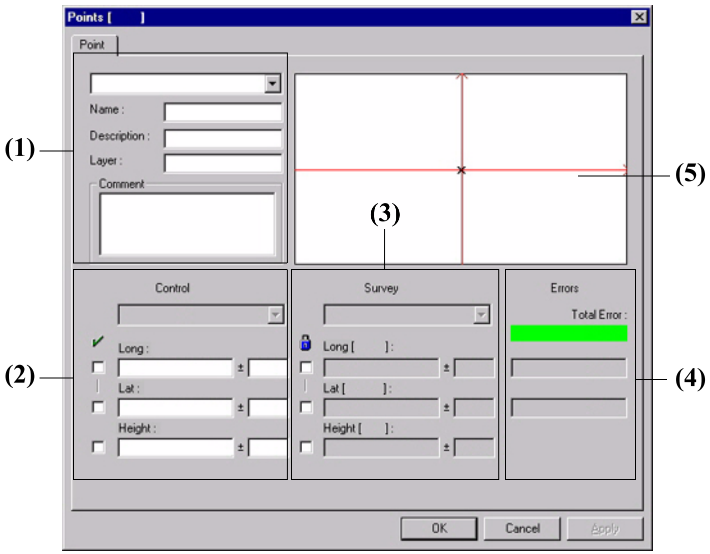
(1): Where applicable, GNSS Solutions calculates the deviations between the theoretical and surveyed coordinates.

(2): Only if the coordinate system used in the project is a projected system.

As the control coordinates of control points are expressed in the project's system, they are automatically transformed if you change the project's system.

As the control coordinates of target and reference points are target coordinates expressed in the local system, they are kept unchanged when you change the project's system (for example when you run a calibration to make the project's system your local system).

Although point properties may take various forms and meanings depending on context and point type, they however all comply with the same box layout, as shown below: (Typically, to open this dialog box, double-click any point displayed in the Survey view.)



(1): This area shows the type and name of the point as well as its description, the layer it belongs to, and a possible comment attached to the point. All point types contain these properties.

(2): This area provides the control coordinates (+ uncertainties) of the point as well as the name of the coordinate system in which these coordinates are expressed. The field containing the name of the coordinate system is set by the software itself.

What control coordinates basically are depends on the point type:

- For a control point, they describe its true position. The coordinates of this position is expressed in the coordinate system of the project.
- For a reference point, these are the point's coordinates expressed in the local system
- For a target point, these are the target coordinates that will be used in the surveying device to guide the field operator to this point. They are also expressed in the local system.
- For a logged or intermediate point, i.e. a point surveyed in the field, this area is not displayed, as no control coordinates are known for this point.

ⓘ The check boxes before the coordinate fields indicate whether the point is 1D (Height box checked), 2D (East, North or Long, Lat boxes checked) or 3D (all boxes checked). Any coordinate you type in a field will not be involved in any processing if you do not check the box located before the field.

(3): This area provides the result coordinates of the point as well as the name of the coordinate system in which these coordinates are expressed (software-set field). Obviously, if you are still in the preparation phase of your survey, and as long as field results have not been downloaded to the project for the point, this area is not displayed in the **Point Properties** dialog box. This is true for all types of points, except for control points. When you create a control point, GNSS Solutions automatically fixes it, which means survey coordinates are defined and set equal to the control coordinates you enter.

ⓘ The check boxes before the coordinate fields allow you to fix the coordinates of the point. What you do when you check one of these boxes is that you overwrite the survey coordinate with the control coordinate. The status of each coordinate is provided between square brackets after each coordinate label and depends on how far you are in the survey and the way you want GNSS Solutions to handle these coordinates. The possible values of status are: Imported, Estimated, Processed (Static), Processed (Dynamic), Fixed and Adjusted.

(4): This area is displayed only when both control AND survey coordinates areas are displayed. It shows the deviation (error) between each control and survey coordinate of the point. A total error is also provided on top of the area. If it is shown on a green background, this means that the total error is less than the **Maximum acceptable control error** (see **Project>Edit settings, Miscellaneous** tab). Otherwise, it will appear on a red background.

(5): This area provides a geographical representation of the point. The point's control coordinates, if any, always define the center of the chart whereas the point's survey coordinates can be anywhere on the chart depending on the position deviation produced by the two sets of coordinates.

❑ Setting a Control Point

When processing GNSS raw data collected simultaneously within a network, coordinates of one or more points should be held fixed. Normally, these are the known coordinates for one of the points. These coordinates are called seed coordinates and the point a control point. You should always choose a site with known coordinates as your control point. If you are not concerned about the control point, GNSS Solutions automatically chooses a point to behave as the control point **but it does not however transform this point into a control point**.

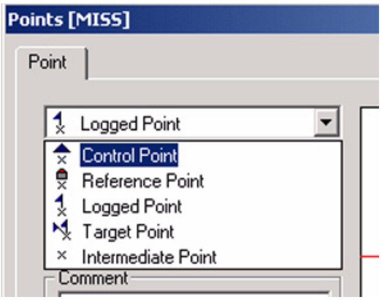
The coordinates for known control points can be entered for use as the seed point in vector processing and as fixed control for the adjustment. Control points can be used as horizontal control only, vertical control only, or both. You have the option of entering a control point but not holding the control values fixed. The advantages of this capability are:

- You can enter all known control points at any time. You may choose to enter all control at the very start of the project. You would select just one point to hold fixed horizontally and one vertically (can be the same point) for processing and the minimally constrained adjustment. When it becomes time to perform the fully constrained adjustment, you simply need to inform the software to hold fixed the other control points.
- You can perform a Control Tie Analysis. You enter all control prior to the minimally constrained adjustment but hold fixed only one horizontally and one vertically. The Control Tie tab of the Workbook will then display the comparisons between the known control values and the adjusted values for those control points you entered values for but did not hold fixed. A large deviation may indicate a problem with the control.

You can set a control point in four different ways:

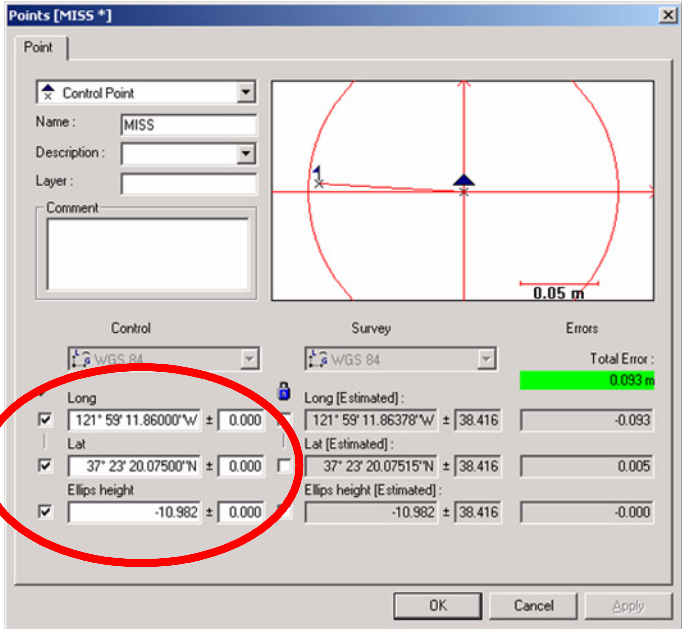
1. Before importing data, as explained in *Chapter 4: Adding Data Files to a Project*.
2. By selecting the **Project>Define Control Points** command. This opens a dialog in which you can set a control point according to a procedure similar to the one described in *Chapter 4: Adding Data Files to a Project*.
3. By using the **Project>Change Into** command. This opens a dialog in which you can change the selected point into a control point. When you do that, GNSS Solutions assigns default control coordinates to the control point. (default control coordinates=survey coordinates). To change the control coordinates of the point, see 4. below.
4. By editing the properties of the point you want to set as a control point:

- In the Survey View or the Workbook window (**Points** tab), double-click the point you want to set as a control point
- In the field top left, select **Control Point**



The dialog box is updated to allow you to enter the control coordinates of the point. By default, these coordinates are preset to those surveyed.

- Enter the control coordinates of the point in the bottom left fields:



- Unless known, set the standard errors of each value to zero (0). The control point will be made a 1D, 2D or 3D control point depending on which check boxes are set before the three coordinate fields (all boxes checked=3D control point).

  The dialog box then gives a visual representation and the value of the deviation between the control position and the surveyed position. This information is also visible in the **Control Tie** tab of the Workbook window.

Data Processing

You can also fix the control point by clicking the check boxes located underneath the lock symbol. When you do that, you assign the control coordinates to the point thus eliminating the notion of error between the surveyed and control coordinates since there is no more surveyed coordinates retained for the point. You usually fix only one control point when you start the processing. In the next step, you will be led to fixing more control points (see *Chapter 6: Adjustment*).

- Click **OK** to validate the control point and close the dialog. In the Survey view, the symbol used for that point is now a triangle.

❑ Editing Site IDs

The Site ID is a very important property of a point. Each point must have a unique Site ID. When an observation is entered into the project with a specific Site ID, a point is created. The Site ID of any existing point can be edited to a different ID. Observations with this Site ID are automatically changed to the new ID.

You can edit a Site ID in a number of different ways:

- Click on the **Points** tab in the Workbook window and double-click in the leftmost cell of the corresponding row. Modify the Name field.
- Double-click (or right-click **>Properties**) on the observation bar of a point in the Time View window to open the Observation Parameters dialog and modify the Site ID name.
- Double-click (or right-click **>Properties**) on the point within the Survey View to open the Point Properties dialog and then modify the Name field.

Changing the Site ID in the Point Properties sheet has a different effect than changing it in the Observation Properties sheet. In the Site Properties sheet, a change in the Site ID changes all observations containing this Site ID to the new value. In the Observation Properties sheet, a change of the Site ID only affects that particular observation.

❑ Editing Antenna Parameters

Invalid antenna parameters are a major cause of blunders during processing including, but not limited to: transposing numbers when writing down the antenna height, reading the height incorrectly, or occupying the wrong point.

If incorrect data (or no data) were entered into the data files, GNSS Solutions provides the opportunity to modify these measurements to ensure valid and reliable processing of the data.

To determine if antenna parameters were incorrectly entered via the handheld, review the field notes from the survey(s).

The three elements defining the location of the GNSS data collection point are Antenna Height, Height Type, and Antenna Type. The Antenna Height and Height Type are inseparably tied together.

Antenna Height:

The Antenna Height is one of three elements that define the vertical offset between the location of the GPS data collection point and the feature being surveyed (survey mark, topo ground shot, etc.). The processing software requires this information to report the elevation of the surveyed feature.

- If the selected Height Type is **Slant**, then the Antenna Height is the measured distance between the feature being surveyed and the Slant Height Measurement Point of the antenna (edge of antenna or ground plane).
- If the Height Type is **Vertical**, then the Antenna Height is the measured distance between the feature being surveyed and the Antenna Reference Point (ARP). The ARP is the very bottom of the antenna.
- If the Height Type is **True**, then the Antenna Height is the measured distance between the feature being surveyed and the C1 phase center of the antenna.

With this information and a selected Antenna Type, GNSS Solutions automatically determines the location of the GPS data collection point and computes elevation values of the surveyed feature.

Antenna Type:

The Antenna Type is one of three elements that define the vertical offset between the location of the GNSS data collection point and the feature being surveyed (survey mark, topo ground shot, etc.). To properly determine the elevation of the feature being surveyed, the correct Antenna Type must be selected for each observation.

With the proper Antenna Type selected, along with the Antenna Height and Height Type, GNSS Solutions automatically determines the location of the GNSS data collection point and computes the correct elevation values of the surveyed feature.

You can select the antenna used for an observation in its Files properties dialog (File tab).

❑ Creating a New Antenna Type

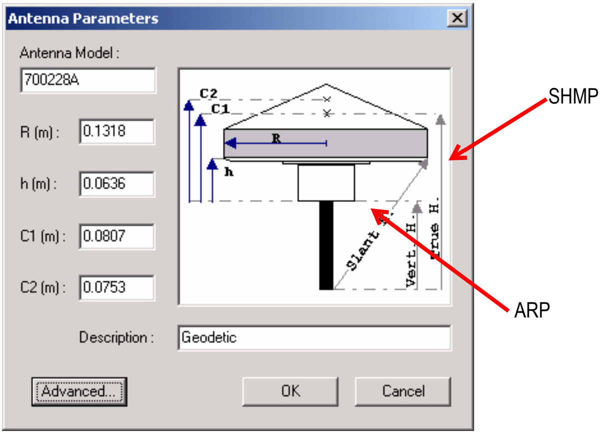
You can create a new Antenna to add to the list of Antenna Types using the **Tools>GNSS Antenna** command or from the File Properties dialog of any observation by selecting <New> in the **Antenna Type** field.

To create a new antenna using the **Tools>GNSS Antenna** command:

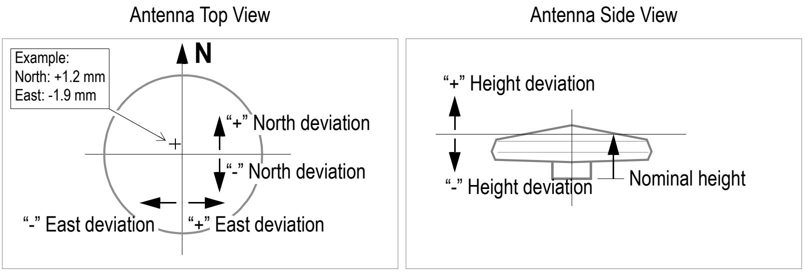
- Select **Tools>GNSS Antenna**. The GNSS antenna dialog lists all the antenna types that can be used in GNSS Solutions
- In this dialog, click 
- Enter the following parameters in the GNSS Antenna dialog:

- **Antenna Model**: Usual name of the antenna
- **R(m)**: Radius, in meters, of the antenna radome

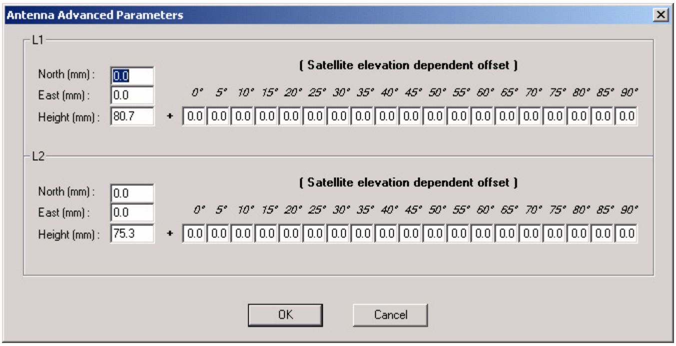
- **h(m)**: Vertical distance in meters between the bottom of the antenna (ARP) and the point on the antenna used to measure the slant height (SHMP=Slant Height Measurement Point)
- **C1(m)**: Vertical distance in meters between the bottom of the antenna (ARP) and the C1 phase center (L1 frequency)
- **C2(m)**: Vertical distance in meters between the bottom of the antenna (ARP) and the C2 phase center (L2 frequency)
- **Description**: Additional information about the antenna (optional)



- If you need to enter more parameters describing the exact locations of the L1 and L2 phase centers, click on the **Advanced** button. This opens a new dialog box in which you can, for each phase center:
- Enter North and East deviations, in mm, from the central vertical axis.
- Enter up to 19 different vertical deviations, in mm, from the nominal height value as a function of satellite elevation angle. The nominal height values you entered previously in the **C1 (m)** and **C2 (m)** fields are displayed for convenience in the two **Height (mm)** fields



Example of advanced parameters screen:



- Click **OK** to validate the advanced parameters and close the dialog box
- Click **OK** again to create the new antenna type and close the dialog box.

When you import an observation file collected with an antenna type that is unknown to GNSS Solutions, this antenna type will appear in bold characters in the Import Data dialog. This means you will have to define its properties when you start importing the file (a dialog will appear at that time so you can enter these properties).

Processing Data

❑ Checking the Processing Options

Run this function after importing raw data files and before running the baseline processing.

- Select **Project>Process Options**. The dialog box that opens shows the processing scenario. An example of processing scenario is shown in the table below:

	Done	Reference	Reference Dat	Rover	Rover Data	Mode	Min Eleva	Deselected SVs	Mask	Orbit Type	L1 L2
▶	☑	FLEU	BP203A05.251	2979	B7006B05.251	Static	10.0		...	Broadcast	☑
	☑	FLEU	BP203A05.251	B7006C	B7006C05.251	Stop & G	10.0		...	Broadcast	☑
	☑	FLEU	B7006B05.250	BP203H	BP203H05.250	Stop & G	10.0		...	Broadcast	☑

The processing scenario consists of a series of processes. In the **Process Options** dialog box, each process occupies a row. A process describes the way a baseline can be processed to produce one or more vectors (one in static, several in dynamic or Stop & Go).

GNSS Solutions automatically builds the processing scenario after you import raw data files into the project or when you run the **Project>Rebuild Process Scenario** command. The way GNSS Solutions operates to determine the scenario relies on the principle explained hereafter. GNSS Solutions orients each baseline described in the scenario in such a way that the first point mentioned is more likely than the other to be a reference point.

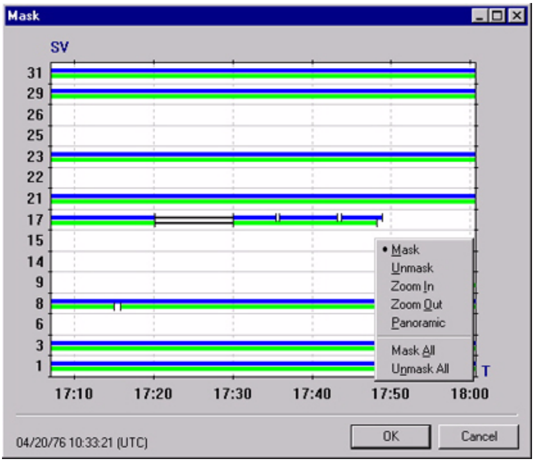
The probability is all the more important as the point is held fixed by the user, is involved in a large number of baselines, and is associated with a long observation.

In addition, GNSS Solutions lists the processes in logical order, after determining which priority should be given to each process, some of them being dependent on the results provided by some others.

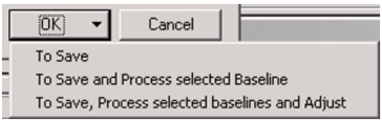
However, you are allowed to freely change the scenario if you think it should be different from what is suggested by GNSS Solutions.

You can for example:

- Move a process up or down by clicking  or  after selecting the corresponding row
- Delete a process by clicking  after selecting the corresponding row
- Invert the orientation of a baseline by clicking  after selecting the corresponding row
- Change the definition of a process by editing any cell in the corresponding row. For example, you can change the processing mode (static/dynamic), the elevation mask angle or the type of orbit data to be used in the processing. You can also intentionally reject L2 measurements or some satellites from the processing. Finally, you can create a mask to be placed over the observation file.
- To create an observation mask for a process, click  in the Mask column. The **Mask** dialog box opens in which you can define a mask graphically for each constellation used (GPS, SBAS, GLONASS). Use the commands available from the pop-up menu to create masks. For example in the figure below, SV No. 17 has been masked from 17:20 to 17:30. To place a mask, right-click on the diagram, select the **Mask** command in the menu and drag a rectangle over the desired satellite and period of time.



- When you agree with the displayed scenario, click on the **OK** button. A drop-down menu is then displayed so you can choose which option suits you best:



- The **To Save** option will only save the processing scenario and close the dialog box.
- The **To Save and Process selected Baselines** option will save the processing scenario and then will process the selected baselines in this scenario. Then the results for these baselines will appear in the different open documents.
- The **To Save, Process Baselines and Adjust** option will in addition adjust the network compared to the second option.

❑ Processing Baselines

- Press the **F5** key, or select **Project>Process All Baselines** (**F6** will only process the still unprocessed baselines). GNSS Solutions will run the last saved processing scenario. The results will appear in the various open views. You will get the following colors to qualify the vectors:
    - Green: QA test was successful for these vectors
    - Red: QA test failed for these vectors.

❑ Processing Events

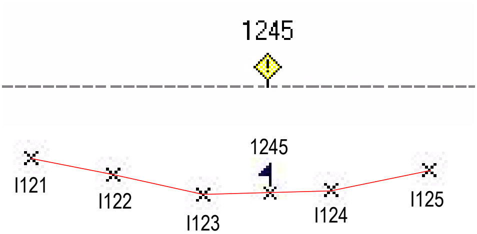
Some user applications require that GNSS Solutions be capable of determining the exact position of the rover any time during a kinematic occupation. The notion of "event" serves this purpose.

Rovers equipped with an external event input can log the exact time when an external signal is applied to this input. This information is marked in the observation file, along with the raw data the rover continuously records.

Events present in an observation file are visible when editing the properties of this file (see *Observation Properties on page 67*).

When processing an observation file, GNSS Solutions also processes the events contained in this file, if any. As a result:

- A point of the type "logged point" (see *Point Properties on page 77*) is created for each event present in the file.
- Each logged point will have the same name as the corresponding event.
- The position of each of these logged points will result from the interpolation of the coordinates of the intermediate point immediately preceding the event and the one that immediately follows along the trajectory.



Post-Processing Data Analysis

The primary product of processing GPS raw data between two points is a vector defining the relationship between these points. Point coordinates are by-products of the processed vector. When a vector is processed, the coordinates of one point are always held fixed. From the processed vector, coordinates are determined for the unknown point.

Prior to adjustment, the point coordinates are derived exclusively from the processed vectors to this point. For points with multiple vectors, the displayed coordinates are derived from the vector with the lowest uncertainties. Adjustment of the data results in more accurate and reliable point coordinates.

GNSS Solutions has indicators to help determine the quality of processed vectors and computed point coordinates. The quality indicators for processed vectors includes a process QA flag, solution type, and vector uncertainties. Quality indicators for computed point coordinates are point position uncertainties and a position status flag.

The vector uncertainties give an estimate of the quality of the processed vector. Experience helps to determine what level of uncertainties can be expected for varying vector lengths. In general, the uncertainties should be similar to the accuracy specifications of the receiver. Also, vectors of similar lengths should have similar uncertainty values.

Notice that the amount of data available for processing a vector has an effect on the vector uncertainty. If too little data is available, the uncertainty values will increase. Refer to your receiver manual to obtain guidelines about the amount of data required for obtaining good results.

The solution type is an indication of the success of determining the integer ambiguities for each satellite in the calculation of a vector. If most of the integer ambiguities were determined, the vector solution is considered a Fixed solution (ambiguities Fixed to integers). A Fixed solution is the best possible solution.

A vector with a solution type Float indicates that not all of the integer ambiguities were determined. In most cases, a vector with a solution type of Float will be poor in quality. If you have a float solution on a shorter vector, there is probably a problem with the data used to produce this vector.

In former Qncarp_ Npcagqgm I *software products, the status could also be "Partial" which is an intermediate status between "Fixed" and "Float". GNSS Solutions algorithms will never produce such "Partial" solutions.*

In GNSS Solutions however, some points will be qualified as "Partial" in the following case: These points, determined earlier by a former Qncarp_ Npcagqgm I *product, were declared as "Partial" solutions and you have imported these points into your GNSS Solutions project.*

The process QA flag examines the magnitude of the vector uncertainties to determine the quality of the processed vector. The magnitude of the vector uncertainties is compared to a threshold value. If the uncertainties are greater than the threshold, the QA test fails and the vector is flagged. The threshold value has been selected based on the expected accuracy for vectors collected and processed in the receiver.

It is important to remember that a flagged vector does not indicate conclusively that the vector is bad. The QA test is designed to warn you of potential problems with a vector. Include flagged vectors in the adjustment. The analysis tools in the adjustment provide additional means to determine if the vector is indeed problematic. If so, it can be eliminated.

The point uncertainties estimate the quality of the computed point position. The uncertainties are derived directly from the vector uncertainties for a point. If multiple vectors exist for a point, the point adopts the uncertainties from the last processed vector. An adjustment on the data improves the point coordinates and reduces uncertainties.

The position status flag gives an indication of how the coordinates for the point have been derived. Flag settings are Estimated, Processed, and Adjusted. Each represents a different level of reliability and accuracy, with Raw being the least reliable and accurate, and Adjusted being the most reliable.

The quality indicators discussed here are presented in different ways within GNSS Solutions, depending on the view used for analysis. The remainder of this section shows how to analyze these indicators in graphical and tabular form.

❑ Graphical Review

Once GNSS Solutions has processed the raw GNSS data, the Survey View changes to show the results of the processing.

The points from the raw data have been processed displaying various information:

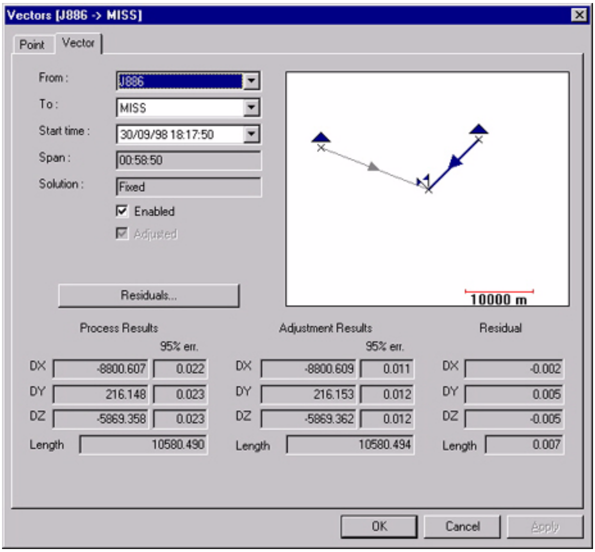
- Error ellipses: Graphical display of the horizontal uncertainties of the vector
- Vertical Error Bar: Graphical display of the vertical uncertainties of the vector

- Vectors: A solid line represents each processed vector. If the vector passes the QA test and has a “Fixed” solution type, the line is green. If the vector fails the test or has a “Float” solution type, the vector is red.

❑ Editing a Vector

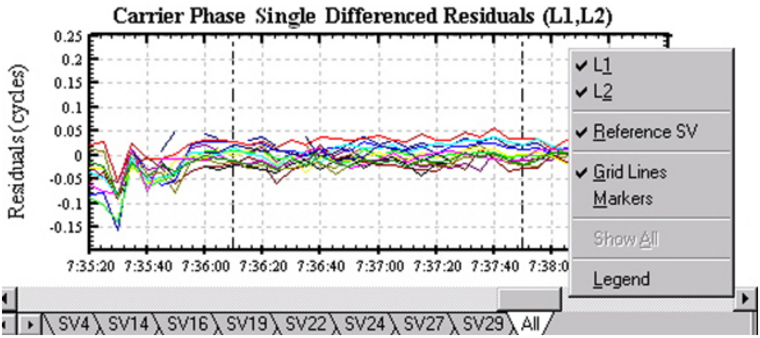
The properties of a vector are presented on a two-tab dialog box. Typically, to open this box, double-click a vector displayed in the active map document.

The **Vector** tab contains the following information:



- **From**: The point taken as reference, and from which the vector originates (shown in dark blue in the above diagram). If the list contains several points, this means that other vector solutions exist that also end to the point mentioned below (in the **To:** field). These vectors are shown in gray in the above diagram.
- **To**: The point where the vector ends
- **Start time**: The beginning of the static occupation that has allowed GNSS Solutions to calculate the vector. If two or more start times are listed in this combo box, several solutions then exist for the vector joining the two points selected above (repeat vectors). The displayed vector solution corresponds to the selected occupation time.
- **Span**: Duration of the selected static occupation (non-editable)
- **Solution**: Solution status (software set): "Fixed" or "Float"
- **Enabled** box: If checked, the vector will be included in the adjustment. If it's not the vector will be rejected from the adjustment phase.
- **Adjusted** check box: Software set. Indicates whether the displayed vector solution has been adjusted (checked) or not (cleared). If the box is checked, then the lower part of the dialog box also shows the **Adjustment Results** as well as the resulting **Residuals**. If it is clear, then only **Process Results** are provided in the lower part of the dialog box.
- **Residuals** button: Provides access to a full-screen diagram showing the Carrier Phase Single Difference Residuals versus Time. This information can be plotted for each satellite, or for all satellites in view during the observation by clicking the corresponding tab in the lower part of the window. Note the presence of two vertical, dot & dash lines showing the limits of the concerned static occupation.

- You can zoom in on a particular area by dragging a rectangle around this area (then press the **Esc** key to zoom out). Setting the viewing options for this diagram is achieved by right clicking anywhere on the diagram and making the desired choices on the menu that pops up (see menu in figure below).



The following characteristics of problem satellite data can cause poor results when processed:

- Gaps in the data caused by extended loss of lock of the satellite. This is characteristic of an obstructed satellite. If all satellite plots have gaps during the same time periods, the missing data may be with the reference satellite.
- A satellite with residuals noticeably larger than other satellites. This is a characteristic of a satellite affected by multipath and/or an active ionosphere. If all satellite plots have residuals that seem larger than normal, the problem may be with the reference satellite.

- A segment of a satellite with residuals noticeably larger than the rest of the same satellite. This is characteristic of a segment of satellite data affected by multipath and/or an active ionosphere. If all satellite plots have a segment with residuals that are larger than the rest or the residuals, the problem may be with the reference satellite.
- A satellite with a sloped residual plot. Residual plots should not be sloped and should have a mean value of 0 cycles. A sloped plot usually indicates a problem with the satellite data. If all plots are sloped, this usually indicates that the reference satellite is a problem.
- A satellite contributing a very small amount of data compared to the other satellites in the data set. Sometimes such a satellite causes problems with processing.

You can remove any data exhibiting the above characteristics and reprocess the vector.

- **Process Results**: Provides the following results for the vector: DX, DY, DZ components and associated uncertainties, plus vector length, in the selected unit
- **Adjustment Results**: Same as **Process Results**. Displayed only after the vector has been adjusted (**Adjusted** button checked)
- **Residual**: Displayed only if **Adjustment Results** are available and displayed. For each result, this pane provides the deviation between initial process and adjustment.

The **Point** tab provides the properties of the point where the vector ends.

❑ Clearing Process Results

You may need to delete all the process results in a project because you realize the processing was run with incorrectly set options. To do this:

- Select **Project>Clear Process Results**. GNSS Solutions will then delete all the baseline processing results which will then disappear from the various open views.

Case of Kinematic Surveys

The processing of GPS data collected in Static mode is rather straight forward with the required steps discussed earlier in this chapter. Processing of GPS data collected in stop&go kinematic and continuous kinematic modes require some additional steps that will be outlined here.

❑ Control Points for Kinematic Initialization

The processing of data collected in kinematic mode is successful only if the kinematic survey was properly initialized at the start of the survey and each time initialization is lost due to an insufficient number of satellites.

To initialize a kinematic survey, the post-processing software must be able to precisely establish the coordinates of one of the points observed by the rover receiver (initialization point) during kinematic data collection.

Alternatively, the precise coordinates of one of the points observed by the rover (initialization point) can be supplied to the processing software. In this case, the coordinates of the initialization point must be precisely known relative to the coordinates of the base point.

There are a number of different methods to accomplish this. Each method is handled differently by the processing software.

Let’s examine each initialization method in detail and discuss the additional steps, with regard to control points, required to prepare the post-processing software to process the data.

1. Static Survey Initialization

One method to determine the precise coordinates of a rover point is to perform a static survey on the first point observed by the rover. By observing this first point in static mode for the required period of time, the processing software will be able to compute the position of this point. This supplies the required point for initialization of the remainder of the kinematic survey.

Processing of kinematic data initialized by first performing a static survey requires no special steps compared to static processing. If you know the coordinates of the kinematic base station and want to hold them fixed, enter them in the **Control Positions** tab. Otherwise, the software will use an approximate position for the base station and hold it fixed for processing automatically. The software will first determine the position of the initialization point and then determine the position of the remaining kinematic points.

2. Bar Point Initialization

The concept of initialization using the initializer bar is similar to using a static survey to initialize your kinematic survey. By performing a 5-minute observation on the bar, you are establishing the coordinates of the rover receiver on the other end of the bar. Once the coordinates of the rover location are established, the kinematic survey can be initialized. A 5-minute observation is all that is needed because we have some initial information regarding the short vector between the base and rover receivers. We know that the vector is exactly 0.200 meters long (the length of the bar). We also know that the delta height of the vector is 0.000 (base and rover receivers are at the same HI). Based on this given information, the coordinates of the rover location can be established with a short 5-minute observation.

Processing of kinematic data initialized by using the bar does require one special step not found in processing static data. The observation on the bar by the rover receiver produces a unique point with its own unique Site ID.

The processing software must be told that this point is the rover initialization point located on the bar. This is the only way that the software knows to constrain the length of the vector and the delta height of the vector for processing. There are two ways to identify a point as the bar initialization point:

- During data collection, the handheld software will automatically tag the bar initialization point. Any point collected with the INI? flag set to Y is tagged in the D-file as the bar initialization point. The processing software will read this tag from the D-file and automatically set the point as the bar point for processing.
- If a bar point was inadvertently not identified as such during data collection, it can be set in the Point tab of the Point Properties dialog.

Once the bar initialization point is identified, the processing of the kinematic data is again similar to that of processing static data. If you know the coordinates of the kinematic base station and want to hold them fixed, enter them in the **Control Positions** tab. Otherwise, the software will use an approximate position for the base station and hold it fixed for processing automatically. The software will first determine the position of the bar initialization point and then determine the position of the remaining kinematic points.

3. Known Point Initialization

If two or more points in your kinematic survey project area have known coordinates, these points can be used to initialize your kinematic survey. The base receiver is set up on one of the known points. The rover observes the second known point for a short period of time (10 seconds for example). This provides a rover point with known coordinates for the processing software to initialize the kinematic survey. If initialization is lost at any time during the kinematic survey, the same or a different known point can be observed for re-initialization. The re-initialization point can even be a point surveyed just moments ago during this kinematic survey.

It's very important to note that the relationship between the base point and the known point to be used to initialize must be very accurately established. For this reason, it is highly recommended that you only initialize on a known point that has been previously established by a GPS survey either with a direct measurement between the base and known point or through a network including both the base and known point.

To process kinematic data where known point initialization was used, the coordinates of the known point(s) must reside in the project file containing the kinematic data to be processed. This can be accomplished in different ways:

- The kinematic data to be processed could be added to an existing project file containing the known coordinates of the base point and initialization points. For example, a project file may exist containing data from a static survey performed earlier that established the coordinates of the known points. The kinematic data to be processed could be added to this project and processed. The processing software will automatically grab the required coordinates for processing of the kinematic data.
- The coordinates of the known points could be added to the project containing the kinematic data to be processed by entering them in the **Control Positions** tab.

If re-initialization was performed on a point observed earlier in the same kinematic survey, there is nothing special that needs to be done to prepare the software to accept this re-initialization. The software will automatically access the coordinates of this point when needed.

4. On-The-Fly Initialization

On-the-fly initialization requires no special data collection procedures. The kinematic survey is initialized without a special initialization process. The user simply turns on the rover GPS receiver and begins collecting kinematic data. If the user can collect a long enough session of continuous data without loss-of-lock on satellites, the kinematic survey will initialize on its own.

The time period of continuous data required to ensure initialization varies depending on a number of factors, the most important of which is GPS receiver type. If using a dual-frequency receiver, on-the-fly initialization can occur with just a couple of minutes of continuous data without loss-of-lock. Under some conditions, up to 10 minutes of data may be needed. On the other hand, if the GPS receiver being used is a single-frequency receiver, such as the ProMark3, you could require 20 minutes of continuous data for initialization.

Processing of kinematic data with on-the-fly initialization requires no special steps compared to static processing. If you know the coordinates of the kinematic base station and want to hold them fixed, enter them in the **Control Positions** tab. Otherwise, the software will use an approximate position for the base station and hold it fixed for processing automatically.

❑ Kinematic Surveys using Multiple Base Stations

It is possible to perform a kinematic survey with more than one base station. Multiple base stations provide for redundant observations to the kinematic points being surveyed. There are no special requirements to processing kinematic data with multiple base stations. Follow the procedures outlined above as if there were only one base station in the survey. The processing software will automatically accommodate the other base stations.

For example, let's say that a kinematic survey is performed using two base stations and a rover. At one base station, the kinematic survey is initialized using the initializer bar. Data collection proceeds as normal, as if there is only one base station.

During the processing of this data, the processing software will first process the vector between the two base stations. Next, the software will process the vectors between the base station with the initializer bar and all rover points. The software knows which base station has the initializer bar by examining the approximate positions of the base stations and the initialization point. Finally, the software will process the vectors from the second base station to the rover points, using one of the already processed rover points to initialize on.

❑ Adjustment

In most situations, there is no benefit in adjusting vectors that have been collected using the kinematic mode of data collection. This is because there is no redundancy in most kinematic surveys. Only one observation exists between the base and each rover point. This leaves nothing to adjust. The exception to this is the situation were multiple base stations are used during the kinematic survey. In this case, closed loops exist between the base points and each rover point. This survey has redundancy therefore can be adjusted.

Conclusion

Once you have completed the pre-process analysis, processing, and post-process analysis, and are satisfied the processed data have no observable errors, you can adjust the data. ❑

Chapter 6: Adjustment

Adjusting your survey observations is one of the most important tasks to ensure accurate, reliable results. A network adjustment is performed to accomplish two results:

- To test for blunders and errors in the observations (vectors between points in our case)
- To compute final coordinates for your survey points which are consistent with the existing control points that you used.

Only data sets with redundant observations (closed loops) benefit from an adjustment. Performing an adjustment on radial vectors (such as those obtained from a kinematic survey with only one base station) will not identify errors in the observations nor improve the accuracy of the points surveyed.

Adjustment takes place after you have processed the raw data and are satisfied that there are no unaccountable errors in the processed results. There are typically two stages in the adjustment:

- The first, the minimally constrained adjustment, is used to detect problems in the observations and control coordinates. You may have to iterate several times, using a number of different tools to check for blunders.
- Once you are confident that no blunders remain, you can proceed to the second stage, the constrained adjustment, where you hold fixed all the control points and readjust to obtain final site positions and accuracies.

This chapter takes a step-by-step approach through the adjustment procedure, and highlights what tools you should use and when to use them. Since it is task-oriented, it does not deal with the theory of adjustments in any depth. Instead, refer to *Blunder Detection Tools on page 358*. You will find it helpful to review this section before actually performing an adjustment.

You do not need to select anything in the project before running the Adjust command as GNSS Solutions will automatically run this command on the entire project, taking into account the possible changes that you have made on some points. Typically, you may have fixed some points horizontally, vertically or both to “anchor” your field survey to known points. You may also have cleared the “Enabled” button for some of the computed vectors in order to reject them from the adjustment phase (see Enabled box in *Editing a Vector on page 98*).

Minimally Constrained Adjustment

The first stage of adjusting your data set is to perform a minimally constrained adjustment; the final product of this stage will be a blunder-free adjustment.

1. With an open project containing a processed data set, click on the **Adjustment Analysis** tab of the Workbook window.
2. Notice all the fields are blank. No data are available until you perform an adjustment on the data set.

   You may choose to hold one site fixed at this point. However, if you do not, the software automatically uses the site with the lowest uncertainty. It is important that you do not hold more than one site fixed.

3. Press **F7** to perform an adjustment or select **Project>Adjust Network...**.
   A progress dialog opens, indicating the adjustment progress and status; you may cancel the adjustment at any time. Relevant messages are displayed in the Output pane.
4. Once the adjustment is complete, data appears in the **Adjustment Analysis** tab of the Workbook window. The table below describes the **Adjustment Analysis** tab.

Component	Description
Reference / Rover	Names of the points forming the vector
Start_Time	Month, day and time for the vector
Adj_QA	Button cleared if any residual component of the vector does not pass the QA test. Otherwise, checked.
Tau_Test	Button cleared if any residual component of the vector does not pass the Tau test. Otherwise, checked.
Adj_Length	3D spatial distance of the vector in the linear unit system selected in the Project Settings dialog
Length_Residual	Residual of the adjusted vector length
Adj_DX	Adjusted vector component in the x direction
DX_Residual	Residual of the adjusted vector component (x)
Adj_DY	Adjusted vector component in the y direction
DY_Residual	Residual of the adjusted vector component (y)
Adj_DZ	Adjusted vector component in the z or vertical direction
DZ_Residual	Residual of the adjusted vector component (z)

The first test GNSS Solutions performs is the Network Connectivity test. This test ensures that the network does not contain any subnetworks that are not connected. Refer to *Network Connectivity Test on page 358* for more information. After this test, text similar to the following appears in the Output pane:

```
Network connectivity test: passed
Number of sites: 6
Number of vectors: 9
```

If this test fails, there are actually two or more unconnected networks in the project. You must either observe more vectors to connect the networks, exclude the vectors for all but one of the networks, or create a new project for each network.

GNSS Solutions then performs a Chi-Square test. For more information about the Chi-Square test, refer to *Chi-Square Test on page 361*. After performing this test, text similar to the following appears in the output pane:

```
Chi-square test: passed
Lower limit: 4.403788
Upper limit: 23.336664
Chi-square: 22.083307
```

Actual measurements may differ in the adjustment of your data files.

After passing the Chi-Square test, the program performs a Tau test for each vector. A Tau test is performed on the residuals of each vector as a test for blunders. The Tau test result for each vector is displayed in the **Adjustment Analysis** tab of the Workbook window. Only those vectors that fail the test are indicated. For more details on the background of the Tau test, refer to *Tau Test on page 365*.

It is important to note that even if some vectors are flagged as failing the Tau test, if the residuals of the vectors are not significantly larger than those for other vectors, it is probably acceptable to ignore the results of the test.

Other tests that are useful in detecting blunders, especially in larger networks, are the Repeat Vector test and the Loop Closure test. Both tests can be used to identify problem vectors - you can exclude them from further adjustment if necessary. See also *Loop Closure Analysis on page 366* and *Repeat Vector Analysis on page 367*.

5. If no residuals are flagged, you should now have a blunder-free adjustment.

6. If more than one control point was entered in the **Control Positions** tab and only one was held fixed (remember that you should hold no more than one fixed at this stage), GNSS Solutions performs a control tie analysis automatically. To see the results, click on the **Control Tie** tab of the Workbook window.

   This test provides an indication of how well your survey agrees with the established control you have entered. If the ties to one of the control points fail and are significantly larger from ties to other control points, then there is good reason to suspect that that control point may be in error. This control point should not be used in the constrained adjustment.
7. Once you have completed the minimally constrained adjustment and have ensured that your network is free of blunders, you can hold fixed all of the control points you have available and perform a constrained adjustment to derive final site positions and network accuracy.

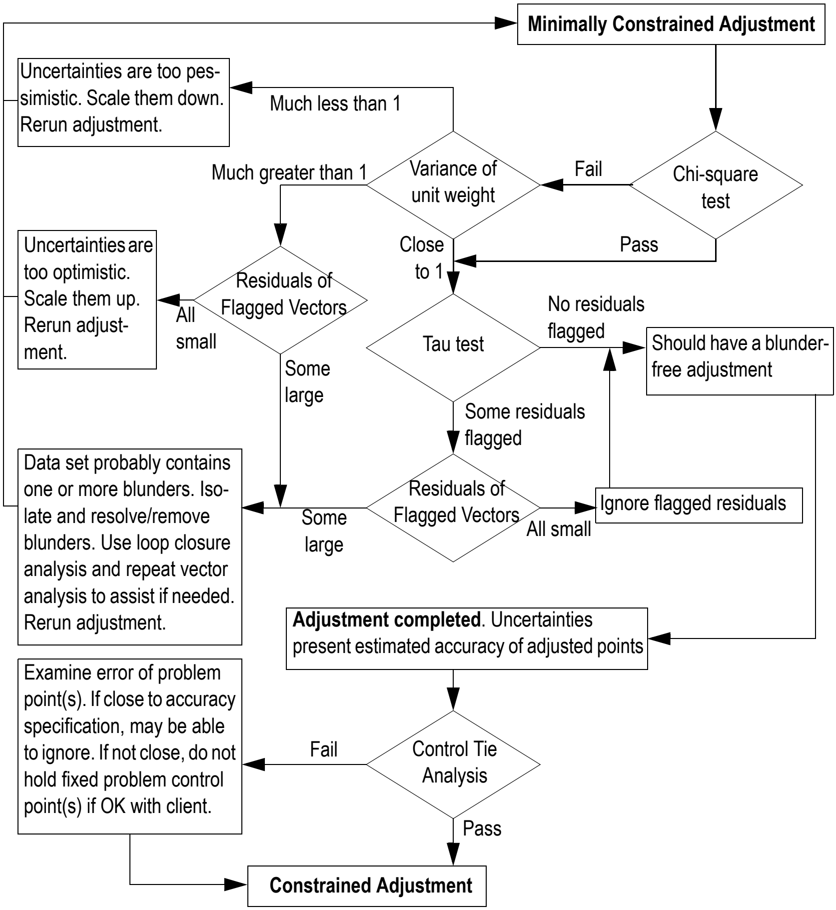
Constrained Adjustment

The purpose of this final stage is to adjust your network, holding all your control points fixed to obtain final positions that are consistent with the established control.

1. Select **Project>Define Control Points** icon
2. Change the fixed status for each control point. You can have points which are horizontal control only, points that are vertical control only, and points which are both. Then click **OK** to close the dialog.
5. Press the **F7** key to perform the adjustment again. You should see text in the Output pane similar to the following:

```
Adjustment type: Over constrained
Control stations Constraints
0002 Latitude Longitude Elevation
_ASH Latitude Longitude Elevation
```

All the tasks described in this Network Adjustment section are summarized in the figure below.


Minimally Constrained Adjustment
Chi-square test
Fail
Pass
Variance of unit weight
Much less than 1
Uncertainties are too pessimistic. Scale them down. Rerun adjustment.
Much greater than 1
Close to 1
Residuals of Flagged Vectors
All small
Uncertainties are too optimistic. Scale them up. Rerun adjustment.
Some large
Tau test
No residuals flagged
Should have a blunder-free adjustment
Some residuals flagged
Residuals of Flagged Vectors
All small
Ignore flagged residuals
Some large
Data set probably contains one or more blunders. Isolate and resolve/remove blunders. Use loop closure analysis and repeat vector analysis to assist if needed. Rerun adjustment.
Adjustment completed. Uncertainties present estimated accuracy of adjusted points
Control Tie Analysis
Fail
Examine error of problem point(s). If close to accuracy specification, may be able to ignore. If not close, do not hold fixed problem control point(s) if OK with client.
Pass
Constrained Adjustment

Clearing Adjustment Results

You may need to clear the adjustments results to resume this phase with different settings. To do this:

- Select **Project>Clear Adjustment Results**. GNSS Solutions will then delete all the data resulting from the last run Network Adjustment function. The adjustment results will then disappear from the Survey View and the Workbook window.

Running a Loop Closure Test Manually

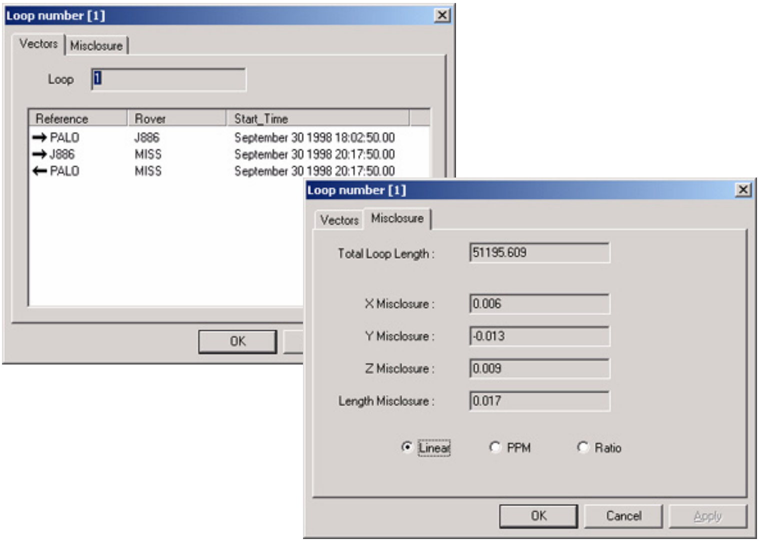
- Select at least three vectors forming a loop on the Survey View
- Select **Project>Check Loop Closure**. GNSS Solutions then performs the loop closure test on these vectors. At the end of the test, GNSS Solutions selects the **Loop Closure** tab in the Workbook window so you can read the results of the test:

Workbook.tbl - Tuto_3 - WGS 84 - Meters

	Loop	Loop_Length	X_Miscl	Y_Miscl	Z_Miscl	Length_Miscl
1	1	51195.609	0.006	-0.013	0.009	0.017

Loop Properties:

- Select a row on the **Loop Closure** tab in the workbook
- Right-click and select **Properties**. A new, two-tab, dialog box is displayed showing the content of the selected row in a different form:



The first tab shows the points involved in the definition of the vectors forming the loop. The second tab give the same results as in the row except that you can choose to view the misclosure results either in a linear, ppm or ratio form.

Suggestions and Recommendations

A minimally constrained adjustment is essential:

- Use the **Control Tie** tab to evaluate the closure on the remaining control points
- Determine what control points are valid and which ones are not
- Do not make a fully constrained adjustment to control points that do not fit together within your error budget
- Print a site positions report from the fully constrained adjustment
- Make sure the control points are well balanced around the project; Remember the saying, "Make a box and work inside the box."

Compare the results of your fully constrained adjustment with the results of your minimally constrained adjustment:

- No points in the survey project should shift by amounts greater than the closing errors shown on the **Control Tie** tab in the minimally constrained adjustment.
- If any point in the project shifts by an amount greater than the closing error, that means the control points are not in balance.
- Control points that are not in balance should not be used to constrain a survey project.
- The purpose of a fully constrained survey is to distribute the closing error in the control points.
- If constraining the control points projects error instead of distributing error, then the control points should not all be constrained.

Sometimes a minimally constrained adjustment is the best adjustment. ❑

Chapter 7: Coordinate Transformations

One of the primary advantages of GNSS Solutions is the ability to work within your own coordinate system from the start of your project - you no longer need to be concerned with transforming to and from the WGS-84 datum, to which all GPS data references. GNSS Solutions allows you to work in five types of horizontal coordinate systems:

- Geocentric
- Geographic (Geodetic)
- Projected (Grid system)
- Projected with Horizontal Correction (Local Grid)
- Ground.

In addition you can choose to use either ellipsoidal heights or orthometric heights. (This is done by setting the Vertical Datum field on the System tab.) Although GNSS Solutions includes many predefined system, you can easily create your own custom coordinate system.

The different types of coordinate systems can be seen to build upon one another. At the heart of any system lies the geodetic datum, with a known relationship to WGS-84, represented by the Geodetic system. On top of that might exist a Grid system, consisting of one or more zones, each utilizing one of the several available projections. Finally, a Local Grid can be superimposed over a Grid system.

Ground Systems can also be created when you wish to produce coordinates in your project area that are compatible with point coordinates derived using conventional total stations. Although different in nature, ground systems are classified in GNSS Solutions as projected systems in which the projection properties are determined by the software itself after you have entered the required parameters (mainly L-G coordinates of the origin point and system orientation).

Typically you select or define the coordinate system you wish to use when you create a new project. From that point on, all coordinates are presented in that system. However, it is possible at any time to change to a different system, and all your coordinates automatically transform to the new system.

Experience indicates that users work primarily in the same coordinate system. For convenience, the coordinate system in a new project is automatically set to the system that was used last.

Introduction

Coordinate systems are organized as summarized in the table below:

System	Coordinates	Definition
Geocentric	X ECEF, Y ECEF, Z ECEF	Datum + System Definition (name units, labels)
Geographic	Latitude, Longitude, Height	Datum + System Definition (name, units, labels, vertical datum)
Projected	Easting, Northing, Height	Datum + Projection + System Definition (name, units, labels, vertical datum)
Ground	Easting, Northing, Height	Datum+geographical coordinates of origin point+assigned coordinates to origin point in ground system+system orientation

GNSS Solutions strictly complies with OpenGIS concerning coordinate transformations.

GNSS Solutions supports the following projections:

- Transverse Mercator
- Transverse Mercator OSTN02 (projection grid)
- Transverse Mercator 27
- Transverse Mercator Alaska 27
- Transverse Mercator 34
- Cassini Soldner
- Lambert Conformal Conic 1SP
- Lambert Conformal Conic 2SP
- Lambert Conformal Conic 27
- Stereographic
- Oblique Stereographic
- Oblique Stereographic RD2000 (projection grid)
- Oblique Stereographic RD2004 (projection grid)
- Oblique Mercator
- Oblique Mercator 83
- Oblique Mercator 27
- Oblique Mercator HD72
- Krovak Oblique Conic Conformal
- Hotine Oblique Mercator
- Ground System
- Ground System Azimuth

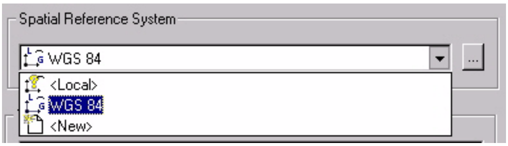
Selecting a Coordinate System

If you create a new project and you do not define its coordinate system during the creation phase, then GNSS Solutions will automatically allocate the coordinate system of the last open project to this new project. To define the coordinate system during the project creation phase, click on the **Modify Default Settings** button in the **New** dialog box, and then complete the **Region** tab.

Once the project has been created, you can come back to the definition of the coordinate system by clicking on the Commands pane, then on the **Project** topic bar, and then on the **Project Settings** icon. Then click on the **Region** tab. As explained elsewhere in the manual (see *Project Settings on page 45*), you select the desired coordinate system for the project in the **Spatial Reference System** field.

Remember that the choice you make in this field is for the entire project but you will be allowed to choose a system specific to each document created within the project without affecting the present choice.

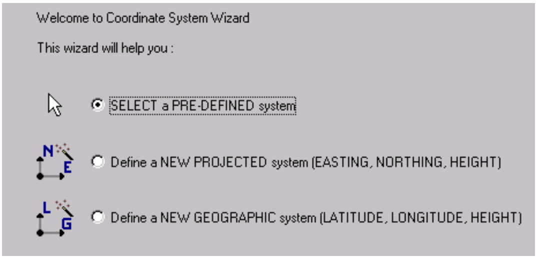
The list of systems attached to the **Spatial Reference System** field contains at least the following three options:



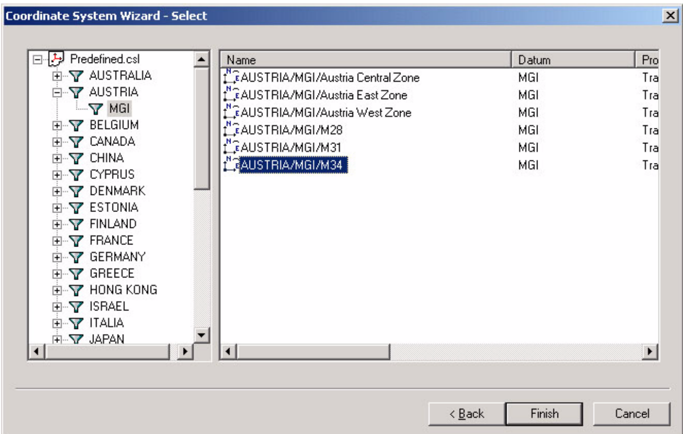
- Selecting **<Local>** will allow you to work in the unknown local system
- Selecting **<WGS 84>** will directly select WGS 84 as the project's coordinate system.

You can edit the definition of the WGS 84 by clicking the ... button next to the field. If you change and enable any of the parameters defining the WGS 84, GNSS Solutions will create a new system named WGS 84~1 by default.

- Selecting **<New>** will display the following dialog box:



- If you check **SELECT a PRE-DEFINED system** and you click the **Next** button, GNSS Solutions will display the list of pre-defined systems (more than 500 available). In this case you just have to select a system in the right-hand list (see example below) and click the **Finish** button.



The selected system name will then appear in the **Spatial Reference System** field. From now on, this system will also be available from the list attached to this field.

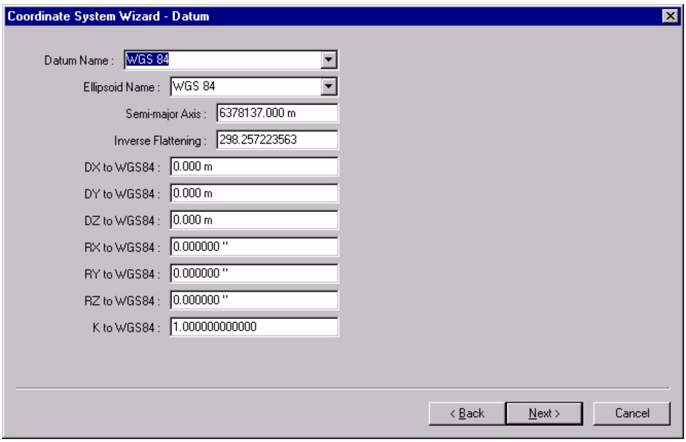
- If you check either **Define a NEW PROJECTED system** or **Define a NEW GEOGRAPHIC system**, then GNSS Solutions will allow you to define a new system (see next pages).

Creating a Projected System

The process of creating a new projected system goes through three distinct phases corresponding to three different dialog boxes, as explained below. To access the first of these dialog boxes, do the following:

- Run the **Tools>Coordinate Systems** command
- Click , check the **Define a NEW PROJECTED system** option and click the **Next** button. This opens the **...Wizard-Datum** dialog box (continued below).

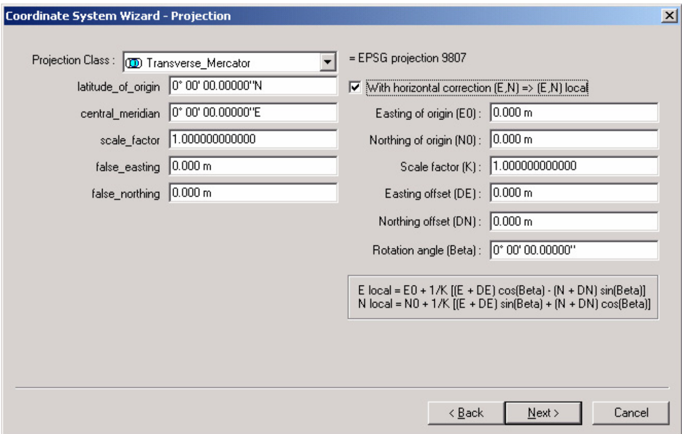
❑ Defining the datum



- There are two different scenarios to define a datum for a new system:
    - The new system relies on a known datum: just select a name from the list attached to the **Datum name** field. The rest of the dialog box (i.e. ellipsoid name and definition + position in space) is updated to match your selection.
    - The new system relies on an unknown datum: type the name of the new datum in the **Datum name** field, then type the name of the associated ellipsoid in the **Ellipsoid name** field. Enter the two characteristics of the ellipsoid in the next two fields and then define the position in space of this ellipsoid with respect to the WGS 84 in the remaining 7 fields.

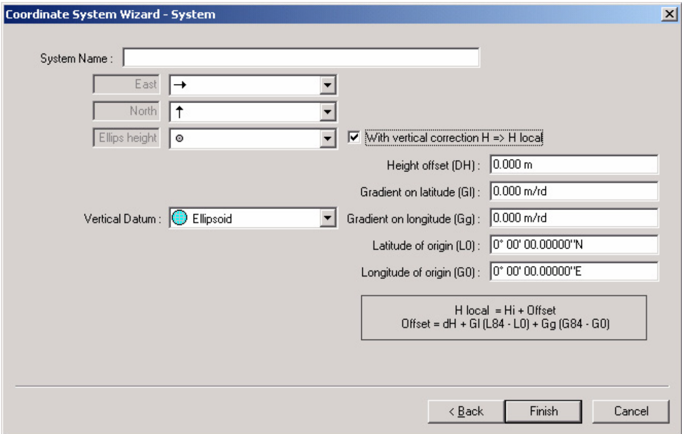
      Note that the datum and the ellipsoid that you create in this second scenario are also intrinsically tied to each other.
- When you have finished defining the datum, click the **Next** button to display the next dialog box (see below).

❑ Defining the projection



- Select the desired type of projection from the list attached to the **Projection Class** field, and then complete the fields underneath
- If the new system includes a horizontal correction, check the box top right. This action unveils a number of fields in the right-hand part of the dialog box that you must complete to define the horizontal correction.
- When you have finished defining the projection, click the **Next** button to display the next dialog box (see below).

❑ Defining the system



- Enter the following parameters to complete the definition of the new projected system:
  - Projected system name
    (Labels and orientation of the three axes cannot be changed)

  - Vertical datum: Choose the option representing the geoid model you would like to use. Choose the “Ellipsoid” option when you wish to use the ellipsoid you have selected earlier for the datum as the vertical reference.
  - Vertical correction: check the corresponding box if the local system includes a vertical correction, and then enter the parameters defining this correction.
- Click **OK** to create the new system and close the dialog box. The new system then becomes the one selected in the **Spatial Reference System** field.

This last dialog will contain more information if, from the menu bar, in **Tools>Preferences**, *you check the* **Advanced Coordinate System settings** *option. With this option enabled, you will be able to set the units and labels used by the system, namely:*

- Labels associated with coordinates

- Unit used for horizontal coordinates (meters, US feet or International feet). For your information, the **Meters per unit** *field indicates the value, in meters, of the selected unit (e.g. 1 Int foot=0.3048 m)*

*- Unit used for vertical coordinates (***Meters per unit** *field: same as above). The check box located bottom left allows you to define the same unit for ALL coordinates when checked.*

Creating a Geographic System

Follow the same procedure as when you create a projected system. The only difference is that you do not have to define a projection.

Creating a Geocentric System

Defining a geocentric system is much like defining a geographic system except that you do not have to define a vertical datum.

Geocentric systems are incompatible with maps and so, in GNSS Solutions, can only apply to table or graph documents. This is the reason why you cannot select a geocentric system at project level. To create a new geocentric system:

- Run the **Tools>Coordinate Systems** command
- Click , check the **Define a NEW GEOCENTRIC system** option and click the **Next** button.
- Complete the two screens allowing the definition of a geocentric system.

Creating a Ground System

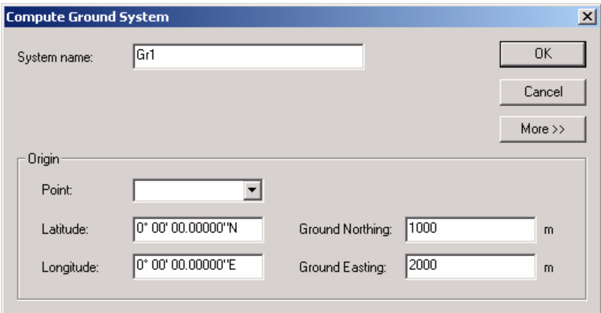
You can create a Ground System in two different ways as explained in the next two sections.

❑ From Within an Open Project

This is the best method to create a Ground System as the definition of the origin point and the orientation of the system is easier. Also, you do not have to specify a datum as the project datum will automatically be used.

- Open your project.
- Select **Project>Compute Ground System**. This opens the **Compute Ground System** dialog box.

- Enter the name of the Ground System in the **System Name** field.
- Click the arrow to the right of the **Point** field and select the origin point for the Ground System from the list presented.
  After selecting an origin point, the latitude and longitude stored in the project for the selected point will be displayed.
  If you would rather set the origin point to a location other than an existing project point, simply enter the latitude and longitude of your origin without selecting a project point. By default, the ground coordinates of the origin point are defined as (0,0). You can enter values other that (0,0) as ground coordinates for the origin point. This is helpful when the origin point is in the center of the project site. Assigning ground coordinates such as (10000,10000) to the origin point will lessen the likelihood of some of the project points having negative ground coordinates.
- Enter the desired coordinates of the origin point, in the Ground System, in the **Ground Northing** and **Ground Easting** fields. Example:



- If you now click **OK**, the new ground system will be computed based on a 0° azimuth to the North for the orientation of the ground system.

If you want a different orientation, click **More>>**. The window is extended to show the possible choices for the orientation of the ground system:

- The **To North** option defines 0° azimuth of the Ground System to match Geodetic North (default option).
- The **To Point** option defines 0° azimuth of the Ground System as the azimuth between the origin point and a second point defined by either selecting the point from the list of existing points in the project or defining a new point by entering the Latitude and Longitude of the point.
- The **Angle** option defines 0° azimuth of the Ground System as offset from Geodetic North by the entered angle. A positive angle results in the 0° azimuth of the Ground System being rotated counter-clockwise from Geodetic North.

- After defining the desired orientation, click **OK** to save the Ground System and close the dialog.

❑ Using the Coordinate System Window

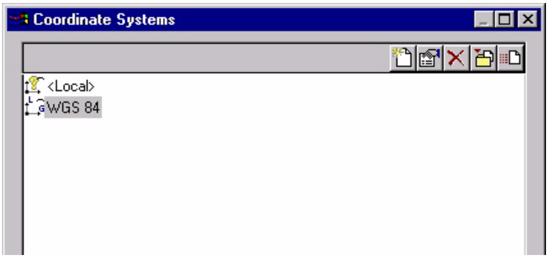
- Run the **Tools>Coordinate Systems** command
- Click , check the **Define a NEW PROJECTED system** option and click the **Next>** button. This opens the **...Wizard-Datum** dialog box.
- Define the datum used and click **Next>**. This opens the **...Wizard-Projection** dialog box.
- Select one of the following options in the **Projection Class** field:

- **Ground_System** if you would like to define a Ground System with North or “To Point” orientation
- Or **Ground System_Azimuth** if you would like to define a Ground System whose orientation is given by an angle.

- Depending on this choice, enter the required parameters to complete the definition of the Ground System
- Click **Next>**. Enter the name of the Ground System in the **System Name** field.
- Click **Finish** to save the Ground System and close the dialog.
- Close the Coordinate Systems dialog box.

Managing Coordinate Systems

- On the GNSS Solutions menu bar, select **Tools>Coordinate Systems...**. The dialog box that opens looks like the one below:



The content of this dialog box determines the list of coordinate systems attached to the **Spatial Reference System** field on the **Region** tab of the **Project Settings** dialog box or on the **View** tab of any **Map** or **Table Properties** dialog box.

The following functions can be performed from this box:

- Edit the properties of a system: select this system and click
- Add a new coordinate system to this list: click , choose the type of coordinate system you want to define and then define this system, or simply select it from the list of pre-defined systems.
- Delete a coordinate system from the list: click after highlighting a system in the list. You can only delete a pre-defined system from this list, not from the list of pre-defined systems. Conversely, a system you have created yourself will be definitively deleted from the coordinate system library if you delete it.
- Import a coordinate system from a file in csl format: click , select the file to be imported from the folder you choose and then click **Open**. The imported system will appear in the list of coordinate systems. Files in csl format are ASCII files that can be uploaded to the data collector.
- Export the selected system to a file in csl format: click after selecting the coordinate system you want to export. Specify the target folder and click **Save**.

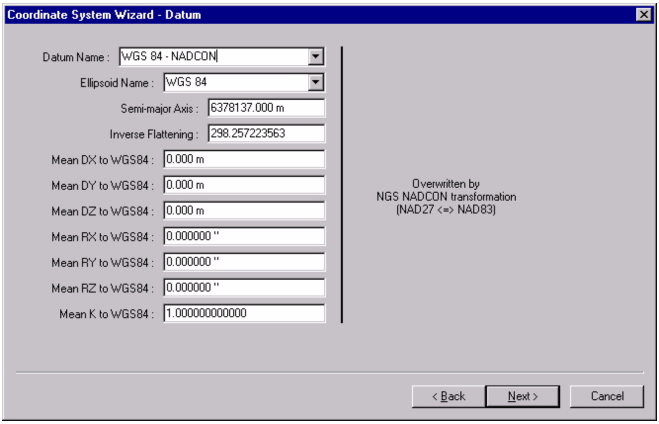
Using Datum Grids

GNSS Solutions lets you work with the following datum grids:

- NADCON
- GR3DF97A
- 3DIM

These grids are somewhat hidden in the software. To use any of them, do the following when you create a coordinate system:

- When you define the datum used, type the name of the desired datum grid (NADCON, GR3DF97A or 3DIM) in the **Datum name** field. This field is a combo box but you can also directly type text in this field. As a result, a message is displayed in the right-hand part of the dialog box (see example below with NADCON).



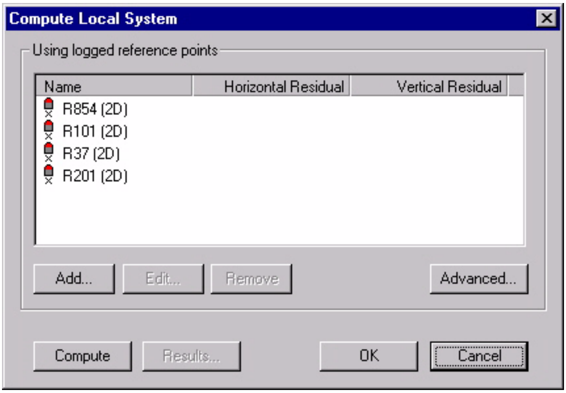
If some points in your surveys happen to be located beyond the geographical area covered by the datum grid, a warning message will appear in the lower part of the Point properties dialog box.

Performing Coordinate Calibration

Use the **Coordinate Calibration** function to determine the local system after you have surveyed a number of points in the field that are in fact reference points in the local system. Determining the local system is typically performed in the field but you can resume this calculation with GNSS Solutions as a safety measure.

Remember that performing a calibration procedure is possible only if the project contains logged reference points with associated field results.

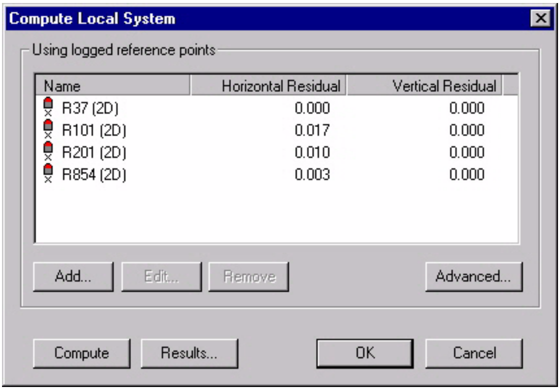
- Select successively each of the surveyed points that are reference points in the local system and, unless already done, change each of them into a reference point so you can enter their known coordinates as control coordinates
- On the map document, make a multiple selection including all these reference points
- On the GNSS Solutions menu bar, select **Project>Coordinate Calibration...**. The **Compute Local System** dialog box appears listing all the reference points you have just selected (see example below).



In this dialog box, the **Advanced...** button allows you to fix a number of parameters in the horizontal grid, if some of them are already known, before running the **Coordinate Calibration** command. If you do not know anything about the horizontal grid, then do not fix any of its parameters.

The **Edit** and **Remove** buttons allow you to edit or remove a reference point you select in the list. By giving you access to a dialog box listing all the reference points present in the project, the **Add** button allows you to involve more reference points in the calibration if needed. The larger the number of reference points involved, the better the coordinate calibration (max.: 20 reference points).

- Once the list of reference points is okay, click the **Compute** button to let GNSS Solutions determine the local system. The dialog box is then refreshed to show the Horizontal and Vertical Residuals (see example below).



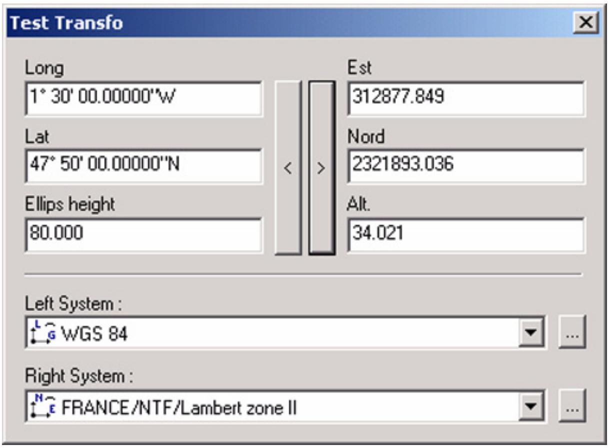
By clicking the **Results...** button, you will be able to read the characteristics of the local system (Datum + Projection + System) resulting from the calibration process. Note that in this case, all the fields are non-editable fields.

Computing Datum Shifts

This function should be used exactly in the same way as the *Performing Coordinate Calibration on page 134*. The only difference is that the present function only determines the set of parameters defining the datum and so assumes that the projection used is correct.

Testing Coordinate Transformations

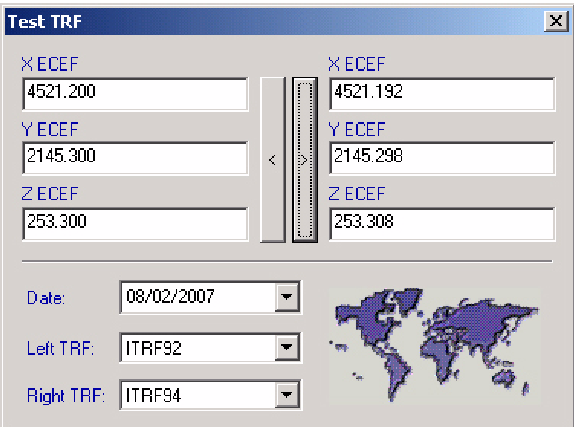
Use the **Tools>Test Transfo..** command to test coordinate transformations from a system to another. You must specify the source and target coordinate systems. Transformations can be run in one direction or the other, which means the functions of "target" and "source" systems can be swapped between the two systems involved, depending on the direction you choose for the transformation.



Making Coordinate Transformations Between Any Two ITRF's

GNSS Solutions allows you to convert coordinates from a given International Terrestrial Reference Frame (ITRF) to another. The conversion can be run for any given day, month and year.

- From the menu bar, select **Tools>Test TRF**.
- Select the "source" ITRF in the **Left TRF** field
- Select the "target" ITRF in the Right TRF field
- In the **Date** field, set the day, month and year for which you want the conversion to be made
- Enter the "source" coordinates in the left-hand part of the dialog (**X ECEF**, **Y ECEF**, **Z ECEF** fields)
- Click the thin vertical button marked with a ">" to convert the coordinates to the target ITRF. The result is shown in the the three fields (**X ECEF**, **Y ECEF**, **Z ECEF**) on the right-hand part of the dialog (see conversion example below).



Note that conversions can also be made the other way round using the "<" button. ❑

Chapter 8: Background Maps

GNSS Solutions allows you to import background maps into a project. Once imported, background maps are shown in the Survey View window.

If the open project contains survey results in the same geographic area, these results will be superimposed on the background maps. The presence of background maps can significantly improve the quality of the reports you print for your customers.

Two different types of background maps can be imported into your projects:

- Raster maps (in BMP, JPG, JPEG2000 or non-compressed TIF format)
- Vector maps (in SHP, MIF or DXF format)

Background maps can be uploaded to an external device, e.g. for use in the field. With this functionality, field operators can more easily locate themselves and find their working areas.

When uploaded to an external device, a vector map is converted into a raster map. This means each individual feature that was initially described in the original vector map cannot be selected on the display screen of the external device. When uploading a raster map, the file is first converted into Geotiff format before being uploaded.

Enabling the Background Maps Function

The Background Maps function is one of the options you can find in the **Preferences** dialog.

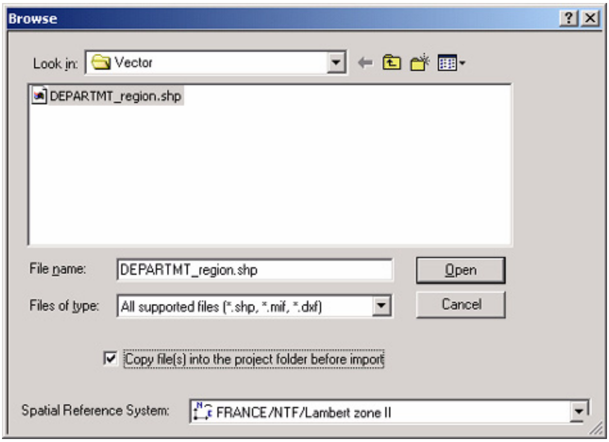
If you keep the default choices when installing GNSS Solutions, then this function will automatically be made active by the installation program.

To check that the function is enabled, select **Tools>Preferences**. The **Show Background Map functions** option should be checked.

To deactivate the function, just clear the check box and click **OK***.*

Importing a Vector Map

- Select **Project>Import Vector Layers**. This causes the **Browse** dialog box to appear.
- From the **Look in** combo box, select the folder containing the vector map you want to import (a MIF, SHP or DXF file).
- Select the file you want to import.
- From the **Spatial Reference System** combo box, select the coordinate system used in the selected file. You are supposed to know this system. If you don't, ask the person who generated the file. If the coordinate system you need is absent from the list of coordinate systems, select **<New>** to create it. See *Chapter 7: Coordinate Transformations* for more information on how to create a new coordinate system.
- If you want to make a copy of this file into your project folder, check the **Copy...** box.

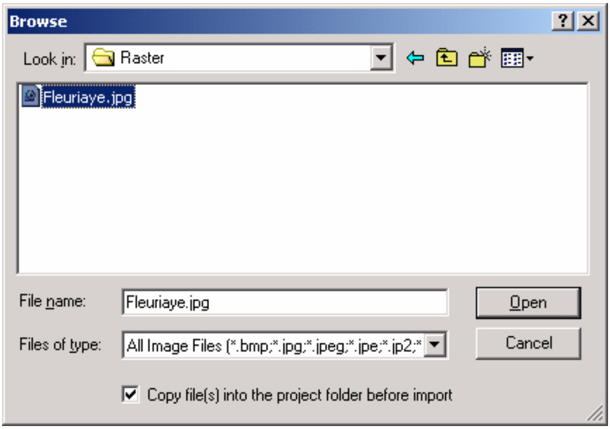


- Click **Open** to import the selected file and close the dialog.

If an error message is reported in the output pane, if no map is displayed at all or if the map appears somewhat distorted, please resume the import operation using the appropriate coordinate system.

Importing a Raster Map

- Select **Project>Import Raster Layers**. This causes the **Browse** dialog box to appear.
- From the **Look in** combo box, select the folder containing the raster map you want to import (a BMP, JPG, JPEG2000 or non-compressed TIF file).
- Select the file you want to import.
- If you want to make a copy of this file into your project folder, check the **Copy...** box.



A new dialog box opens showing part of the map stored in the selected file.

(Click if you wish to reduce the size of this window:)

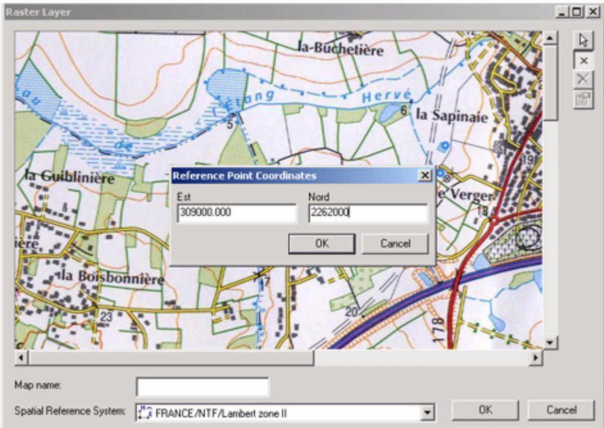
- In the **Map name** field, enter a name for the raster map, e.g. “Carquefou”
- In the **Spatial Reference System** field, select the name of the coordinate system on which the raster map is based. This system may be different from the one selected in the project. GNSS Solutions will automatically perform coordinate transformations whenever necessary. (If you don’t know the name of the coordinate system used, ask the person in charge of scanning the maps to give you these coordinates.) If the coordinate system used is not listed in the combo box, select **<New>** and create this system (for more information on how to create a coordinate system, see *Chapter 7: Coordinate Transformations*.)

Sizing & Importing the Raster Image:

The raster map being still dimensionless, you need to give it geographical dimensions. To do this, you have to define at least **three** reference points whose coordinates are accurately known in the system used.

- In the Raster Map window, right-click on the map and select **Add reference points**.

- Find marks on the map –generally cross-hairs– surrounding your working area for which the original paper map can provide accurate coordinates. By “original paper map” we mean the map you scanned to create the raster file you are now importing.
- Determine these coordinates on the paper map, reading the map’s legend and grid lines, and then write down these coordinates. (If you don’t have the original paper map, ask the person in charge of scanning the maps to give you these coordinates.)
- In the Raster Layer window, find and click on the first mark and then enter its coordinates in the dialog box that shows up nearby.



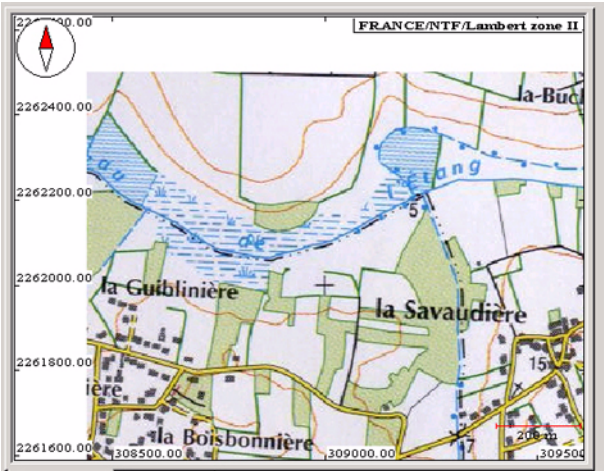
- Then click **OK**.
- Use the horizontal and vertical scroll bars to access the second mark.
- As previously, click exactly on this point and then enter its coordinates.
- Create a third reference point using the same procedure.

  Make sure your reference points are evenly distributed over the working area.

If you created a reference point with wrong coordinates or you simply want to delete this point, do the following:

- Top right of the window, click then click on the reference point you want to edit or delete
- Click to delete the point then confirm the deletion
- Or click to edit its coordinates. Then correct the wrong values and click **OK**.

- Once all the reference points are created, click **OK** at the bottom of the dialog to import the file and close this dialog. The raster map will appear in the Survey View. You may need to adjust (zoom/pan) the view to see the raster map.



Deleting a Background Map

You can delete a background from a project by doing the following:

- Right-click anywhere on the Survey View and select the **Legend** option.
- Scroll down the list of layers until you can select the background map you wish to delete.
- Select this background map, click on  located in the upper-right corner of this dialog box and then click **OK**. As a result, the background map will disappear both from the Survey view and the project.

Uploading a Background Map to ProMark3

You can upload several raster or vector maps to ProMark3. You can even upload a combination of several of these maps through a single upload procedure.

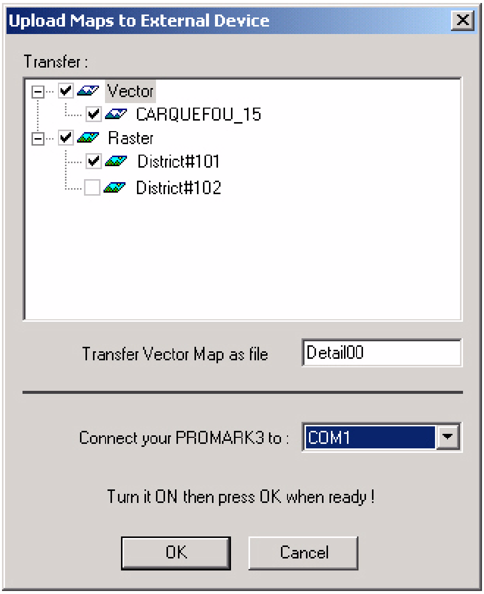
If you select one or more vector maps for uploading, GNSS Solutions will merge all these maps into a single one before uploading it to the ProMark3. For this reason, GNSS Solutions will ask you to name the resulting map (default name: Detail00).

If you select more than one raster map for uploading, GNSS Solutions will keep these maps unchanged and as many maps will be seen on ProMark3 after the uploading.

Follow the procedure below. The map or maps you want to upload must have been imported in the open project otherwise no data will be uploaded.

- Connect the ProMark3 to a USB port on your office computer using the cable supplied with your ProMark3.
- Turn on the ProMark3 and then double-tap the **Surveying** icon to launch this function.
- On the PC, unless already done, launch GNSS Solutions and open the project containing the map you want to upload.
- Select **Project>Upload Maps to External Device**.

- Check on the buttons corresponding to the map you want to upload. For example to upload a raster map named “District#101”, check on the Raster button and the “District#101” button.



- In the same dialog, at the bottom, select the USB port used to communicate with the ProMark3.
- If the map you want to upload is a vector map, you can rename the map (default name: “Detail00”) so this name be used on the external device to identify this map. You cannot rename a raster map.
- Click **OK** to upload the map. ❑

Chapter 9: Reports

This chapter covers the procedures for producing a printed copy of your project data. The report software lets you select the information you want to print, and automatically inserts the selected parameters into a standard RTF-formatted report that can be edited and printed by any standard word processing program. It is assumed that you have created a project and completed the processing described in the preceding chapters, and you now want to compile the results.

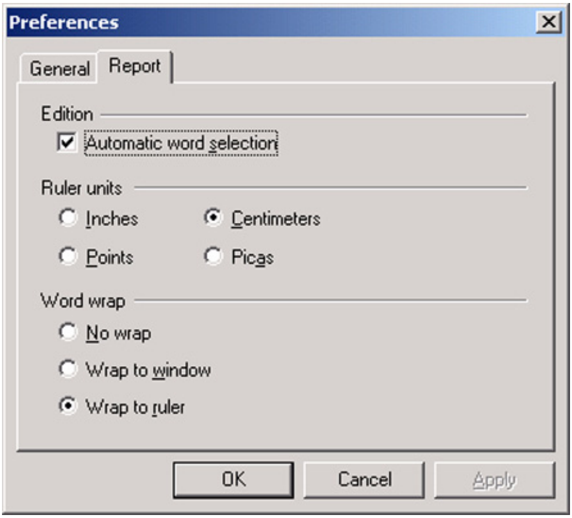
GNSS Solutions allows you to create almost instantly a survey report for your clients or for your archives. This report will be part of the project and, in the GNSS Solutions main window, will share the same area as the Time and Survey views. To switch from the report view to the Time or Survey View, simply click on the corresponding tab at the bottom of this area.

The process of creating a survey report is based on the use of a VB Script macro stored in the ...\Studio\Macro folder.

You can create as many reports as necessary in a project. GNSS Solutions will automatically name these reports in the form “Land Survey Report#”.

Customizing Reports

Before generating a report, select **Tools>Preferences** and then click on the **Report** tab. You can now make the following choices:

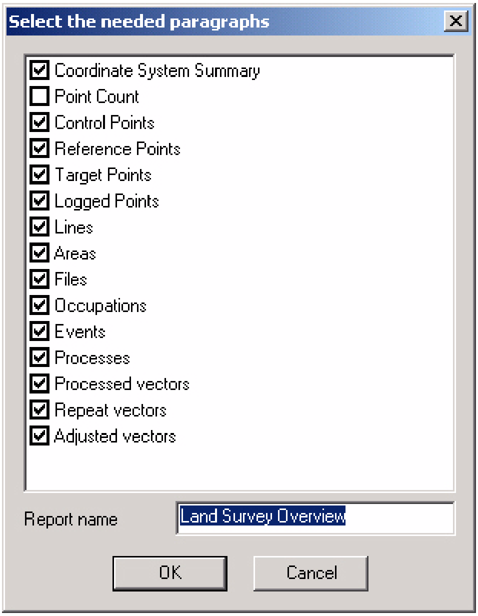


- **Automatic word selection**. If you clear this option, you can select any section of text from within the generated report. If you check it, GNSS Solutions will automatically extend your selection to entire words.
- **Ruler Units** (inches, centimeters, points, picas): Defines the graduations used on the ruler located on top of the report window once a report has been generated.
- **Word wrap**: Depending on this choice, the text present in the report will either extend to the right without any limit (**No wrap**) or will be pushed to the next line when coming up against the right fence of the window (**Wrap to window**) or the right end of the ruler (**Wrap to ruler**).

Creating a Report

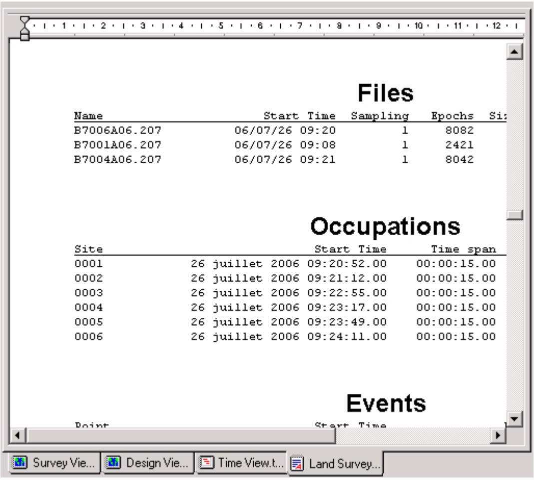
To create a report:

1. Press the **F9** key or select **Project>Land Survey Report**
   This opens the following dialog in which you can choose which topics you wish to include in the report:



2. Check the topics you want to include, clear those you want to exclude
3. Name the report
4. Click **OK** to let GNSS Solutions create the report according to your request.

This is a sample of what a survey report looks like on the screen:)



Once generated, reports can freely be edited: sections of text can be deleted or replaced, etc. With the report window active in GNSS Solutions, you can also use the functions available from the **Report** menu to format the document:

- **Font...**: Lets you choose a font for the current selection
- **Bullet Style**: Adds/removes a bullet at the beginning of the selected paragraph
- **Paragraph...**: Lets you define the characteristics of the selected paragraph
- **Tabs...**: Lets you set tabs for the selected paragraph.

You can also define the width of the document by selecting all the text in the report and then dragging the 2 markers on the ruler to the desired positions.

Inserting a Map into a Report

By adding maps into your reports, you will give more legibility to your results and make your clients happier.

Follow the procedure below to insert maps:

- Make sure the report document in which you would like to insert a map is open.
- Click on the Survey View tab.
- Set this View in such a way that all the elements you would like to see on this view are visible.
- Click anywhere within the Survey View to make it the active view in GNSS Solutions.
- From the menu bar, select **Edit>Copy view.**
- Click on the tab showing the name of your report to make this report the active view in GNSS Solutions.
- Click inside the report where you would like to insert the content of the Survey View (indicate the insertion point)
- From the menu bar, select **Edit>Paste**. As a result, the exact duplicate of the Survey View appears in the report as an image. This image is placed at the insertion point.
- From the menu bar, select **File>Save report** to save the report file.

You can insert as many different maps from the Survey View as necessary. To do this, resume the procedure above as many times as necessary. Each time you do that, make sure the Survey View shows what you would like to insert in the report and also make sure you indicate the insertion point in the report document before pasting. ❑

Chapter 10: Exporting Data

Exporting Data to a File

- Select the data you want to export. You can make this selection on a map document or in a table document showing this data.
- On the GNSS Solutions menu bar, select **Project>Export Geo Data to File...**.
  The table below summarizes all export formats supported by GNSS Solutions versus the type of exported data.

Export Format	Points	Vectors	Features
NMEA (*.txt file)	✓		
TDS (*.CR5 file)	✓		
Carlson (*.CRD file)	✓		
User-defined	✓	✓	
Ashtech (O*.* file)		✓	
AutoCAD (*.DXF file)			✓

- Browse on your disk to select the folder where to store the export file and enter a name for this file
- Click the **Save** button to export the data to that file.

Creating Custom Formats

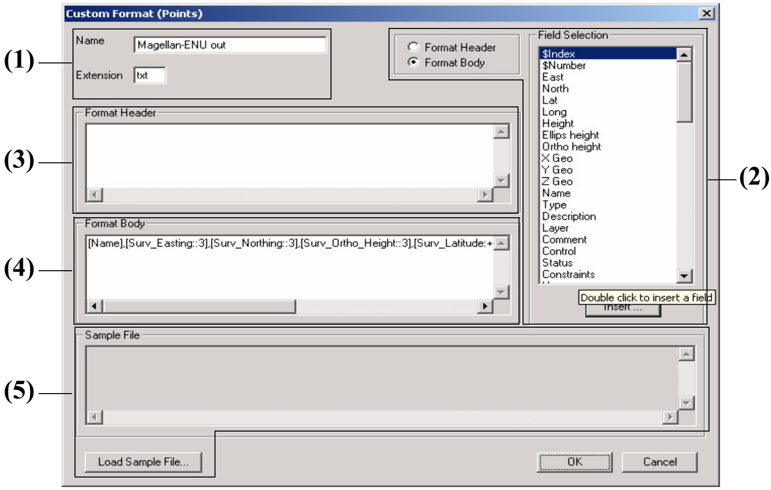
With GNSS Solutions, you can easily create a data import or export format suited to your needs. All the creation process takes place within a single dialog box that you can access by following the procedure below, after opening a project in GNSS Solutions:

- On the GNSS Solutions menu bar, select **Project>Import Geo Data from Files...** or **Project>Export Positions to Files on Disk...**
- In the left-hand area of the dialog box that opens, select **Points** or **Vectors**, depending on the type of object for which you want to create a custom format
- Click on  to create a new format, or  to make changes to an existing custom format after selecting its name in the right-hand list. The dialog box that opens allows you to define a new format or to modify the existing custom format.

This dialog box is divided into 5 main areas as shown in the figure on the next page:

- Area allowing you to name the file that will contain the created custom format (1)
- Area allowing you to choose the parameters that can be inserted into the custom format + insert button + Header/Body selection buttons (2)
- Area for editing the header of the custom format (3)
- Area for editing the body of the custom format (4)
- Area allowing you to view a file containing data that you would like to output via the custom format you are currently defining. (5).

Dialog box allowing you to create a custom format:

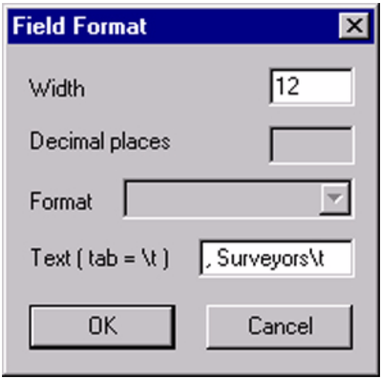


To create a new custom format, follow the instructions below:

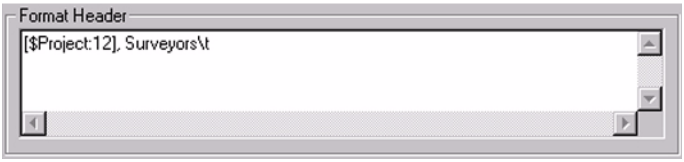
1. In the **Name** field, enter a name for the new format. In the **Extension** field just below this field, enter the file extension (3 characters max.; default: txt) for the created file
2. Start with the definition of the header by checking the **Format Header** radio-button. All the fields that can be inserted into the header are listed in the **Field Selection** list box
3. Choose one of these fields from the list and click on the **Insert...** button. A new dialog box opens asking you to specify formatting instructions for this field

Depending on the type of the field, you will have to define its length (width), the number of decimal places if it's a numeric field, its format if it's a date, time or geographical coordinate, and possibly the associated text (use \t to insert a tab within the text box).

For example, you can enter the following formatting instructions in this box after you have selected **$Project** in the list:



4. Click **OK**. The **Format Header** edit box now contains the following information:



You can change the formatting parameters by selecting them directly from within this edit box.

The "Width" parameter you have just defined is located just after the field name, within the square brackets, and is separated from the name by the ":" symbol.

If you could have defined a number of decimal places for this field, this number would have been inserted just after the "Width" parameter, also separated from this parameter by a ":".

Example: SdZ:8:2 means that the "SdZ" numeric field will occupy a total of 8 characters, 2 of which will be dedicated to the fractional part. If the field value fits in less than 8 characters, then leading spaces will be inserted to fill the field. The decimal point occupies one character.

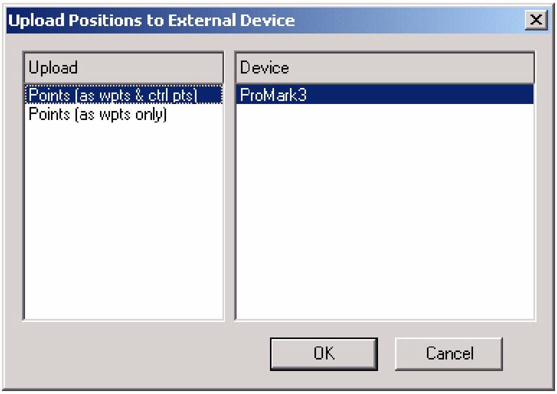
5. In the **Format Header** edit box, you can also create a new line, by inserting a carriage return, to type text directly in this box
6. Check the **Format Body** radio-button. All the fields that can be inserted into the format body are now listed in the **Field Selection** list box
7. Follow the instructions from points3. to 5. above to create the format body. The instructions mentioned in the dialog box are an alternative to the procedure described above
8. Click **OK** to save the newly created format. The name of the new format is now listed on the right in the initially selected dialog box (**Import...** or **Export...**).

❑ Uploading Waypoints & Control Points to ProMark3

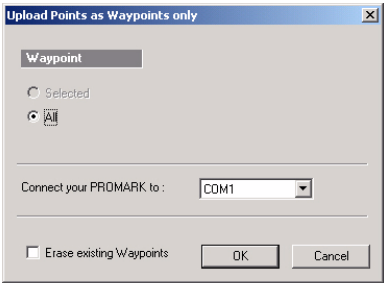
Any type of point from a GNSS Solutions project can be uploaded to a ProMark3 as a waypoint.

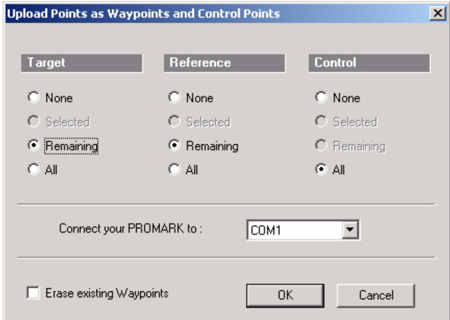
Only control, reference and target points from a GNSS Solutions project can also be uploaded to ProMark3 as a control point. When you create a control point in ProMark3 through this procedure, ProMark3 automatically duplicates this point in its memory as a waypoint.

- Select **Project>Upload Positions to External Device**.
- In the dialog that opens, choose between **Points (as wpts & ctrl pts)** and **Points (as wpts only)**, depending on whether you want the uploaded points to be transformed into respectively waypoints only, or both waypoints and control points:



- Click **OK**. A new dialog box opens giving all the instructions to complete this upload operation:





- First choose whether you want to upload all the points from the project or only some of them. If you have selected some of them before selecting this function, **Selected** will be the default option, otherwise the **All** button will be checked on. On the screen shown on the right, you can trim your selection of points to be uploaded by using the **None**, **Selected**, **Remaining** and **All** buttons for each of the allowed point types (i.e. target, reference and control points).
- Then connect the ProMark3 to the PC using the appropriate cable.
- Turn on the ProMark3 and then launch the Surveying function.
- Back to the above dialog, indicate the port used on the PC to connect the receiver
- Choose whether you want to erase the existing waypoints in the receiver or not (Check or clear the **Erase existing waypoints** button)
- Click **OK**. This uploads the points to the receiver according to your request (GNSS Solutions will automatically find the correct baud rate to communicate with the receiver). ❑

Chapter 11: RTK Projects

The RTK function allows you to support for real-time surveys as well using GNSS Solutions. Once enabled in GNSS Solutions, the RTK function allows you to do the following:

- Creating a project for a real-time job. This includes, in addition to setting the usual parameters of a GNSS Solutions project:
  - Creating a feature code list
  - Importing points from files generated by third equipment
  - Creating points using the Map toolbar.
- Uploading the real-time job to the rover unit. This procedure is based on the use of the SurvCom utility.
- Downloading the real-time results into a project, or combining them with those of a post-processing project.

Enabling the RTK Function

- Select **Tools>Preferences**
- Check the **Show RTK functions** option
- Click **OK** to close the Preferences window. This makes the RTK feature immediately available for use.

Creating a real-time (RTK) Project

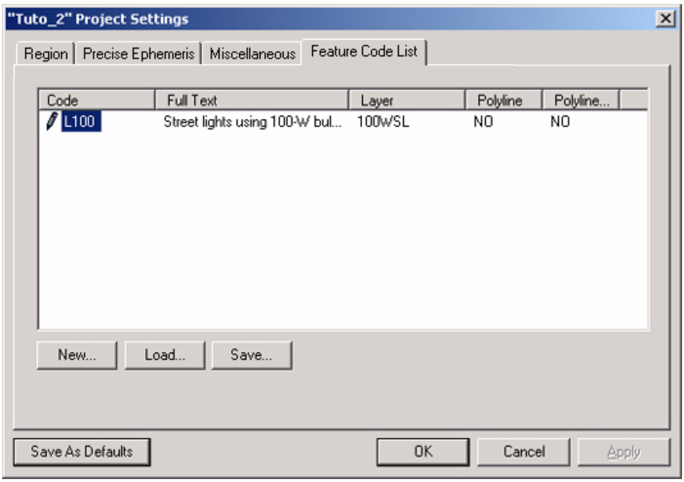
RTK projects are created exactly in the same way as post-processing projects (see *Creating a New Project on page 35*). The only difference is the presence in RTK projects of an additional tab called “Feature Code List” in the project settings.

This tab allows you to define a list of feature codes for the project. These feature codes will be uploaded to the surveying system as part of the job and are intended for field operators. The list of feature codes can be saved as a FCL or TXT file.

Editing the Feature Code List

With your project open, do the following:

- Select **Project>Edit Settings...** or, in the Command pane, click on the **Project** topic bar and then on the **Project Settings** icon.
- In the **Project Settings** dialog now open, click on the **Feature Code List** tab. This tab looks like this:



- Use the following buttons to create or edit feature codes:
  - **New...** button: opens the **New Feature Code** dialog box from which you can define a new feature code. GNSS Solutions will then add the feature code you define to the list of existing feature codes. (See explanations on the next page.)
  - **Load...** button: allows you to load a *.fcl file containing a list of feature codes that you wish to use in the project
  - **Save...** button: allows you to save the list of feature codes currently shown in the **Feature Code** tab as a *.fcl file. Use this button when you wish to use this list of feature codes later and you do not want to waste your time typing these entries again.
  - In addition, you can select a feature code by clicking the corresponding code in the leftmost column. After a right click on this code, you can delete this feature code or display its properties.

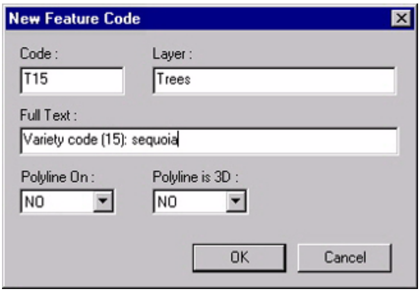
Adding a new feature code:

- As explained on the previous page, on the **Feature Code** tab, click the **New...** button. This opens the **New Feature Code** dialog box.

The following parameters need to be defined in this dialog box:

Code	An abbreviated code displayed on the display screen of the surveying equipment to help the operator classify the points she/he has to survey in the current job (19 characters max.)
Layer	Name of the family of elements to which the code presented above refers
Full text	A description clearly explaining what's behind the code presented above
Polyline On	Polyline On =YES means that all the points surveyed successively will by default be assigned the above code and so will form a polyline with point Ids incremented automatically. Polyline On =NO means the opposite, namely each new surveyed point should be defined manually as to which code should be assigned to it
Polyline is 3D	Relevant only if Polyline On=YES Polyline is 3D=YES means that all the surveyed points will be 3D points (horizontal coordinates + vertical coordinate) Polyline is 3D =NO means that all the surveyed points will be 2D points (horizontal coordinates only)

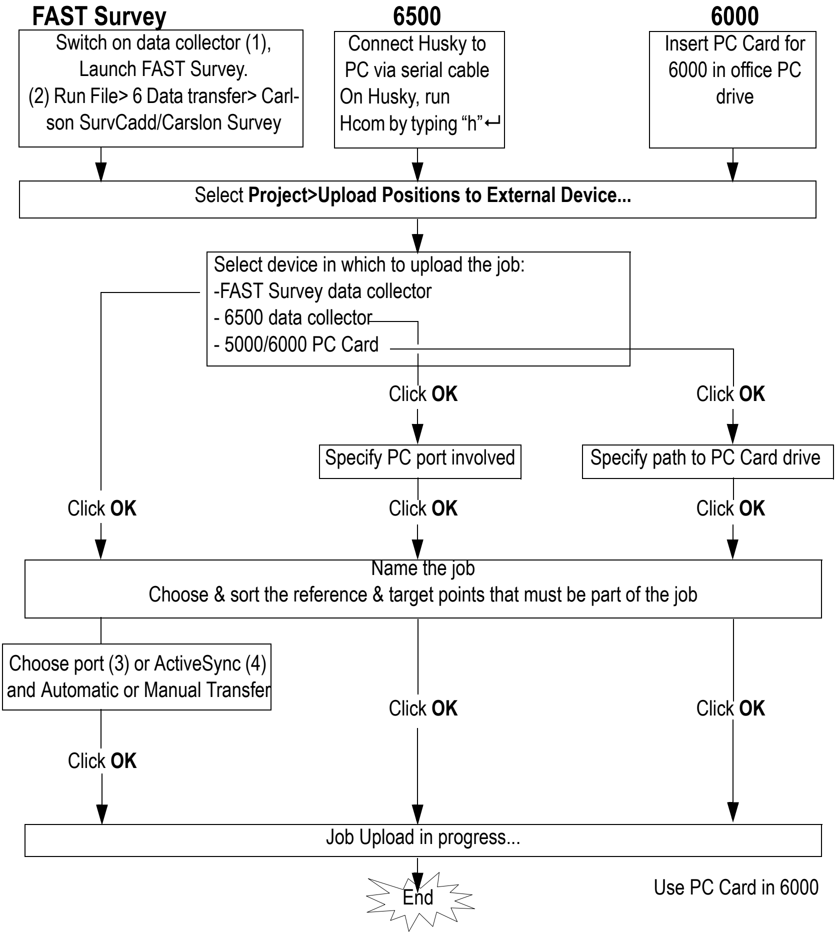
Below is an example of a feature code defined as explained above:



- Click **OK** to create the new feature code and close the dialog box.

Uploading a Real-Time Job

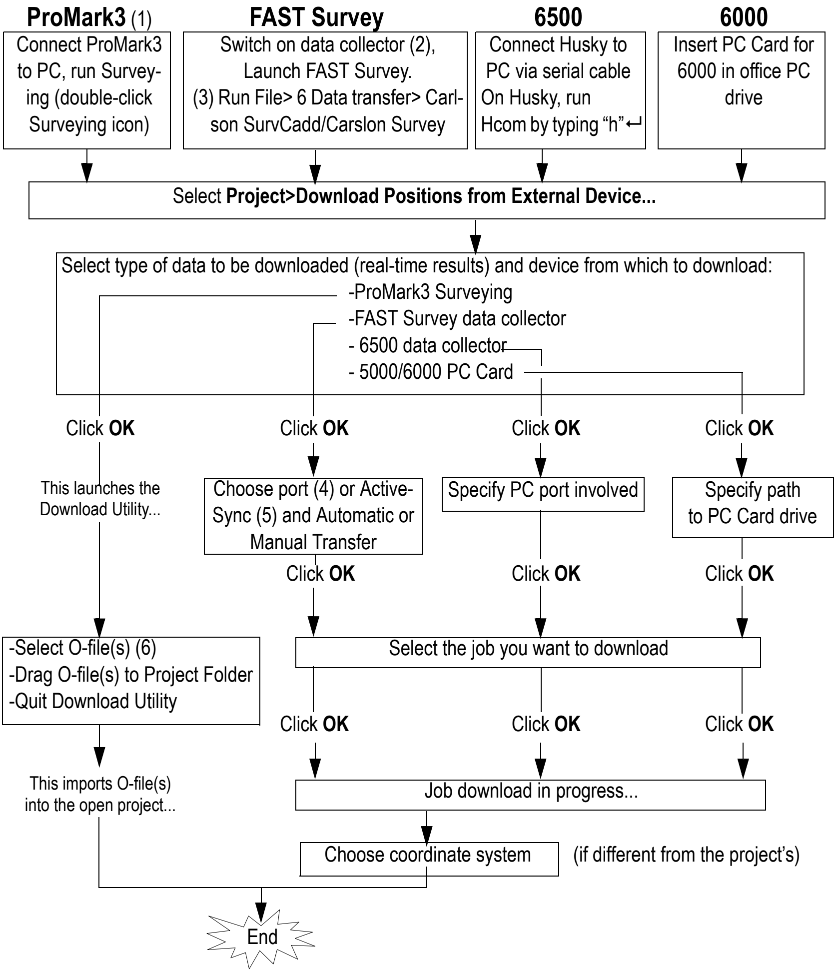
The diagram below summarizes the different steps through which GNSS Solutions can provide FAST Survey software, a 6500 or 6000 unit with a job.



(1) ProMark3 RTK or field terminal used with ProMark 500 or Z-Max.Net.
(2) Skip this step with ProMark 500.
(3) ProMark3 RTK, Z-Max.Net.
(4) ProMark 500.

Downloading Field Results

The diagram below summarizes the different steps through which GNSS Solutions can retrieve field data collected by FAST Survey, 6500 or 6000.



(1) ProMark3 RTK.
(2) ProMark3 RTK or field terminal used with ProMark 500 or Z-Max.Net.
(3) Skip this step with ProMark 500.
(4) ProMark3 RTK, Z-Max.Net
(5) ProMark 500.
(6) O-files contain position data computed from the moment the ProMark3 RTK user pressed "LOG" on the screen until she/he pressed "DONE".

Chapter 12: Advanced Features

GNSS Solutions' advanced features fall into two categories: *Data Management* and *CAD*.

- *Data Management*– This option enables the following functions:
  1. Capability to create additional documents in a project (these documents can be appended to the report you deliver to your customer):
     - By giving access to the project database, this option lets you choose the data you would like to show in these documents.
     - By giving access to user-settable legends, this option allows you to customize the presentation of this data in these documents.
     - These documents are part of the project and are all saved when you save the project

     Documents fall into 5 different types: *Time* documents, *Map* documents, *Table* documents, *Report* documents, *Graph* documents

     You will notice that the *Time View*, the *Survey View* and the *Workbook* window are in fact the default documents of any project you create. The Time View is a time document, the Survey View is a map document and the Workbook window is a table document. With the Data Management option activated, the content and legend of each default document can also be re-defined.

     Access to the project database collections also allows in-depth analysis of the project data.

2. Capability to split the data of your jobs into several independent projects grouped in the same *workspace*.

   You may need this functionality when for example you have several days of data recording for a given job and you wish to keep the data for each day independent from each other but you also want to be able to combine them in a further step.

- *CAD*– This option enables the following functions:
  1. Automatic creation of the *Design View* when creating a new project. This view only shows points or features –not baselines, vectors or error ellipses– and so gives a clear view of the project and its final results. A special feature of the Design View is that its legend is automatically updated whenever new feature codes are created in the project (through the **Feature Code List** tab of the **Project Settings** dialog box).

     If you also activate the Data Management option, the Design View will appear as a map document, like the Survey View, which you will be allowed to customize.
  2. Capability to manually draw lines and areas on the Survey View or in any other map document with the appropriate legend.
  3. Capability to individually assign layer names to points and so create representations specific to these points based on their layer names
  4. Capability to automatically draw lines or areas on the Design View –or any other map document with the appropriate legend– based on layer names assigned to points.

Data Management

❑ Activating the Data Management Option

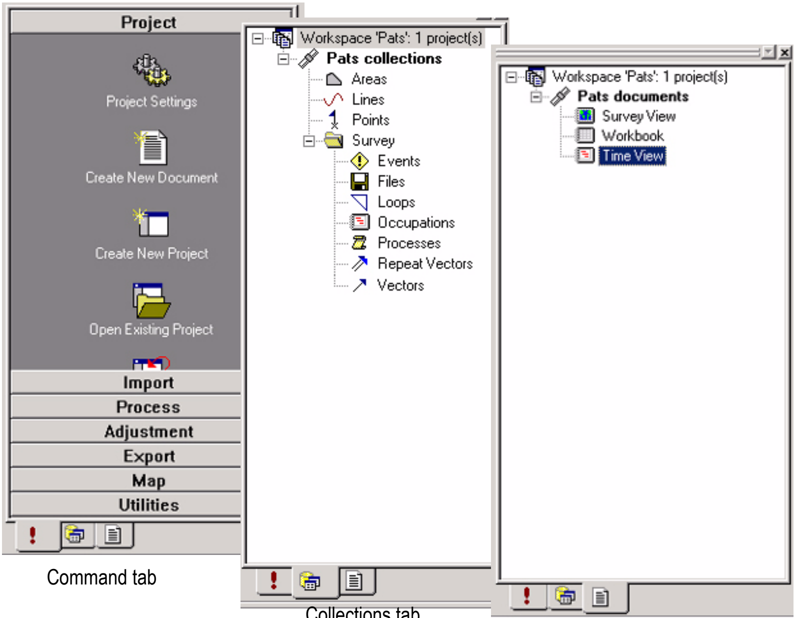
- Select **Tools>Preferences**
- Check the **Data Management** option
- Click **OK** to close the Preferences window. The Data Management features are now available for use.

❑ Description of the New Main Window

When you activate the Data Management option, the area in which the Command pane was previously located is now a 3-tab area. In addition to the Command tab are the Documents and Collections tabs:

- The Collections tab shows the architecture of the project database. Double-clicking any of the listed collections allows you to display the properties of this collection.

- The Documents tab shows the list of documents attached to the project. Double-clicking any of the listed documents allows you to open this document.



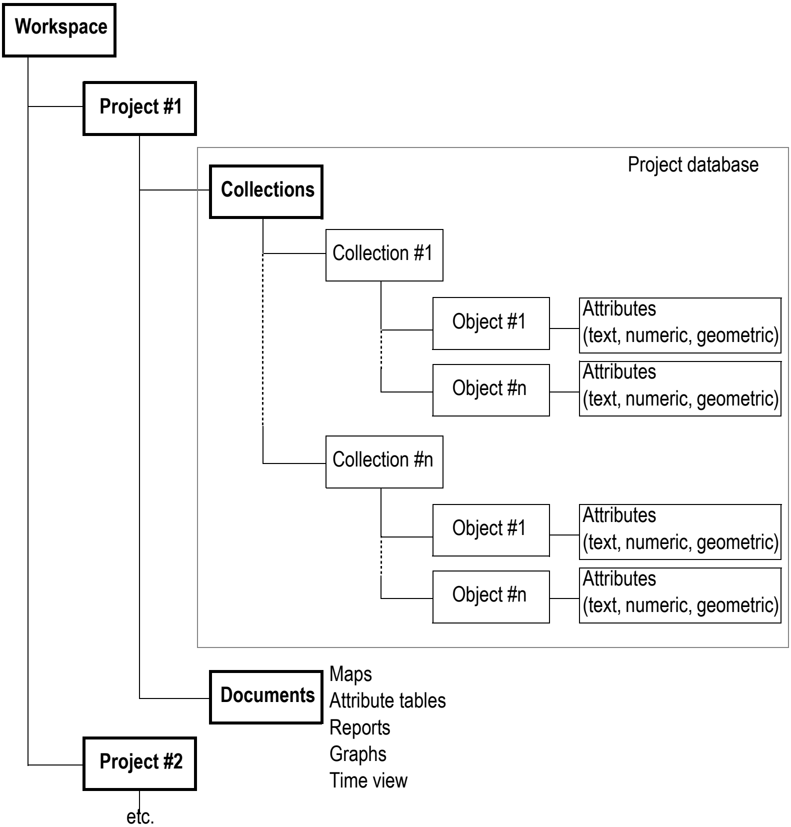
Command tab Collections tab Documents tab

This new area, with its three different tabs, is called the “Workspace pane”.

In addition, the area in the main window where all open documents are displayed is called the “View Pane”.

❑ Workspaces, Projects, Documents, Databases & Collections

Every new project that you create with GNSS Solutions relies on the following architecture (that you can clearly see when the Data Management option is activated):



Workspace: Contains one or more projects (5 max.). Any project created previously from another workspace can be inserted into the open workspace, for the sole purpose of being seen from within this workspace.

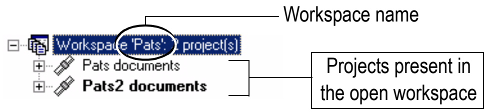
Project: A repository for your field data.

Collections: Each collection contains a number of objects like points, files, vectors, etc. Each object is defined by a list of attributes, plus a geometric attribute defining the location of the object on the surface of the Earth.

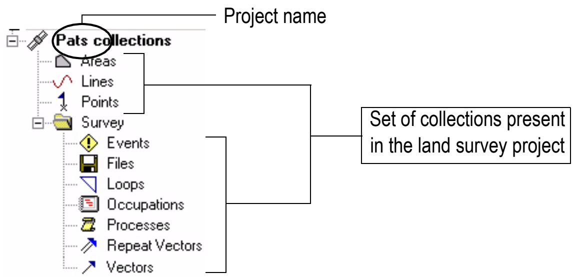
Documents: Five possible types: map, table, time view, report and graph. Documents are created to show the content of the project database from a particular angle.

The open workspace and the projects it contains are shown in the Documents tab.

Example of workspace:



The project database looks like this:

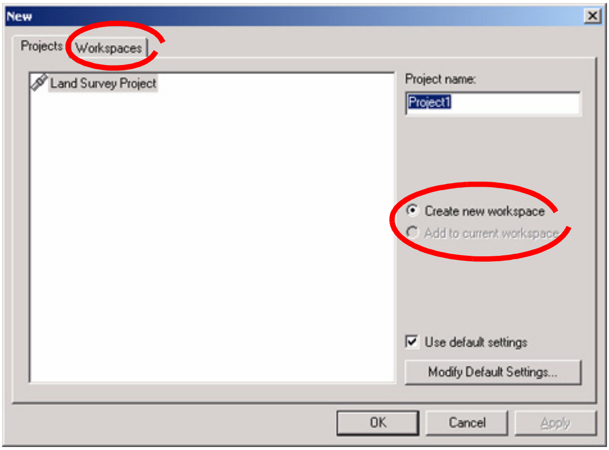


To know more about the different collections you can find in a project, refer to *Database Collections on page 203*.

❑ Creating a Project with Data Management Enabled

To create a new project in a new workspace, you must first create the new workspace and then the project in the workspace. Assuming there is no project open in GNSS Solutions:

1. Select **File>New**. Notice the following two changes in the New dialog box compared to the dialog you would obtain without the Data Management option activated:
   - Presence of a new tab named “Workspaces”
   - Presence of workspace-related options on the **Projects** tab



2. Click on the **Workspaces** tab and then enter the name of your workspace in the **Workspace name** field.

3. Click **OK** to create the new workspace. Although the main window stays blank, the newly created workspace is in fact open in the window.
4. Select **File>New** again and this time enter the project name in the **Project name** field.
5. Make sure the **Add to current workspace** option is checked
6. Click **OK** to create the new project in the current workspace. The project is created and displayed with its default documents.

   If you create a new project with the **Create new workspace** *option checked, GNSS Solutions will not only create a project with the specified name but also a workspace with the same name. The new project will be saved in the new workspace.*

Assuming a project is already open in GNSS Solutions, you can include the new project in the currently open workspace by doing the following:

1. Select **File>New**. Note the presence of a third tab (Documents) in the dialog box that opens:
2. Click on the **Projects** tab and then enter the name of the new project in the **Project name** field
3. Check **Add to current workspace**

4. Click **OK** to create the new project. The project is created and displayed with its default documents.

   The new project becomes the *active* project in the workspace, which means you are only allowed to work on the documents and collections of this project.

- To switch to another project in the workspace (i.e. make it active), select **Project>Set Active Project** and then the name of the project you wish to make active. When you do that, all the default documents from the active project are open in the View Pane and all others are closed.

  To combine data from different projects grouped in the same workspace, refer to *Combining Data from Different Projects on page 201*.

❑ Map Documents

1. Representing Database Collections in a Map Document

Almost any collection in a project database can be represented on a map. GNSS Solutions refers to styles to visualize objects from collections. Styles can be user-modified.

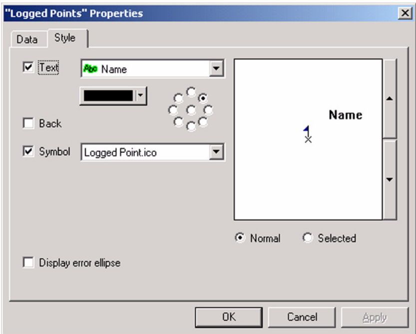
A style is defined by the following parameters:

- Name of the attribute chosen to identify the objects in the collection. For example, you can use the point name or one of its feature codes to identify all points on the map.
- Text color (name)
- Background color (behind name)
- Line or fill style for collections of lines or areas
- Icon assigned to objects (defined as a file stored in .../GNSS Solutions/ Symbols). The user can create new icons if required and store them with the existing ones.

- Icon size
- Name position with respect to the icon.

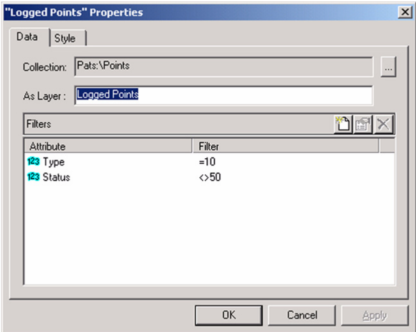
An example of Style dialog box is shown below. To view this box:

- Right-click anywhere on the Survey View of the open project
- Select **Legend**
- Select the “Logged points” layer in the list
- Click .



You can decide on which objects from a collection you would like to show on the map, thus making the other ones invisible. This choice is made by setting a display filter.

From the previous screen, click on the **Data** tab to access the filter definition parameters:



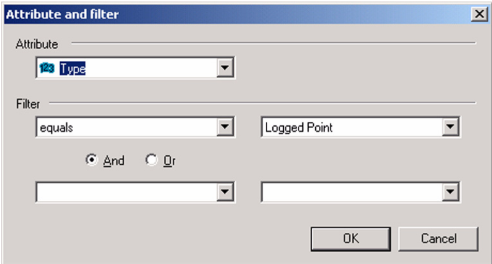
In this example, the display filter has two criteria:

- Type=10
- Status<>50

These are coded criteria. To know the exact meaning of the first criterion:

- Click on "Type"

- Click . A dialog box opens showing the definition of the criterion which is “Show only points from the Points collection of the “Logged Point” type”:



- Click **OK** to close the dialog.

The second criterion can be read in the same manner:

- Click on “Status”
- Click . The second criterion is: “Show only points from the Points collection that have not been adjusted”.

In fact GNSS Solutions converts any text-string-based filter criterion that you choose into a number. The reason is that it is easier for the software to handle numbers rather than language-sensitive text strings. This may be confusing though. So please, refer to *Filter Codes in Legends of Map Documents on page 372* to know the correspondence between the criterion you choose and the number set by GNSS Solutions to process this criterion.

Let's now introduce the following two important terms:

- **Layer**: visual result on the map of a style and a filter applied to a collection of objects
- **Legend**: the set of layers defined in a map document.

Knowing these definitions helps you understand what a map document really is. In fact, when you save a map, you just save its legend.

It is easy to imagine how interesting map documents are. What appears when you open the map document depends on the contents of the project database that time. The same map can show very different things at different times (for example at the beginning and then at the end of a survey).

Finally, once you have defined a map document with a nice legend that you would like to re-use in future maps, you can save this map document as a default map document. All projects created later will then include this default document.

For more details, see *Adding a New Layer to a Map Document on page 179*.

2. Creating a Map Document in an Open Project

- On the GNSS Solutions menu bar, select **File>New**
- Select "Map" on the **Documents** tab. Name the new document by typing a name in the **File Name** field.
- Click **OK**. A new blank map document opens in the View pane.

3. Adding a New Layer to a Map Document

Representing any object from a collection in the project database requires the use of a *layer*. In any project that you create, there is a number of default layers created by GNSS Solutions itself. However, you can create as many layers as necessary for a given collection.

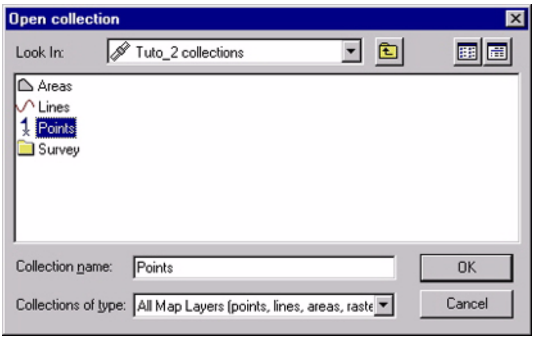
For example, with points, you can create as many types of layers as there are different types of points.

To add a new layer, you have to:

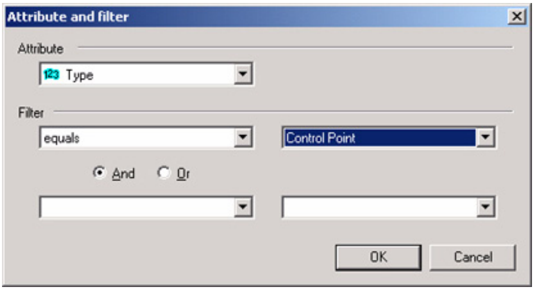
1. Choose the collection on which the layer will apply to
2. Name the layer
3. Define a filter on the attributes of the source collection. In fact, the definition of the layer will result from the choices you make in this step
4. Define a style (icon and associated text) specific to the layer. GNSS Solutions will refer to this style to represent each of the objects meeting the layer criteria.

In the example below, you will create a new layer called “Control Points” referring to any object from the Points collection for which Type= Control Points. This will be done using one of your projects containing control points. First, you will create a new map document as explained in *Creating a Map Document in an Open Project on page 179*. Then:

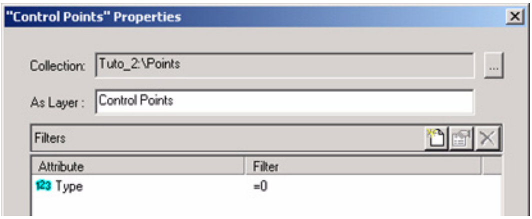
- On the menu bar, select **Map>Legend**
- On the **Legend** tab, click 
- In the new dialog box that opens, select “Points”:



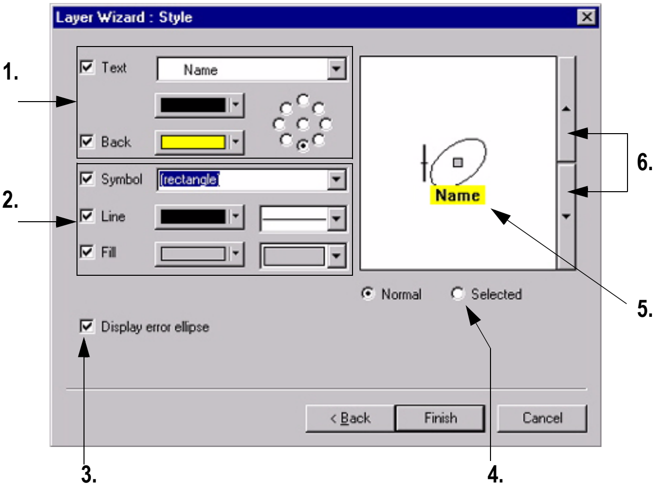
- Click **OK**. In the **Layer Wizard: Data** dialog box that opens, type a name (e.g. “Control Points”) for the new layer in the **Alias** field.
- Then click on the right. A new dialog box opens.
- In this dialog box, set the attribute filter as shown below:



- Click **OK**. Your current filter setting appears in a new dialog box:



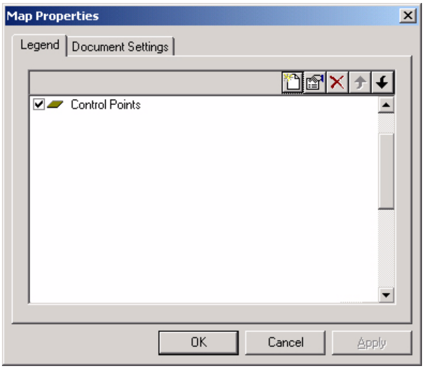
- Click **Next**. The **Style** dialog box now displays. You can do the following to customize the appearance of an object type on the map:



1. Label definition area. If you clear the Text button, there is nothing else to be defined in this area. If on the contrary this button is checked, you have to define:
   - The attribute used as label
   - The color used for characters
   - Background color (if Back button checked)
   - Location of the label with respect to the icon (9 preset locations)

2. Icon definition area. If you clear the Symbol button, there is nothing else to be defined in this area. If on the contrary this button is checked, you have to choose the representation of the object in the combo box opposite the button.
   Then, depending on the symbol chosen, you have to define additional parameters, such as:
   - Line color and width
   - Fill color and effect
3. Shows/Hides error ellipse tied to the point. Ellipse centered on the point. Vertical precision represented as a vertical segment positioned next to the point
4. Check this button to see what the object looks like when selected
5. This area is constantly updated to show the aspect of the object as you define the style
6. Use these buttons to adjust the size of the object on the map.

- When you have finished with the style definition, click the **Finish** button. The new layer now appears in the **Map Properties** dialog box.
  As a default setting, the check button located before the layer name has been checked so that all the objects meeting the layer criteria be seen on the map:



This dialog box includes a number of buttons that can be used for the following:

-  to modify an existing layer
-  to delete the selected layer from the legend
-  to move the selected layer upward in the list. The layer positioned first in the list is brought to the front on the map.
-  to move the selected layer downward in the list. The layer positioned last in the list is sent to the back on the map.

- Click **OK** to close the dialog box.

❑ Table Documents

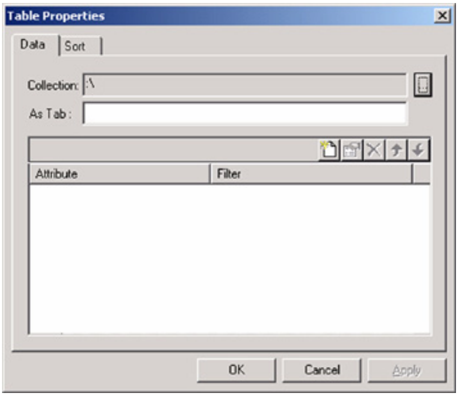
Table documents may consist of one or more tabs. Each tab contains a table that you can customize according to your needs. For instance you can add/delete data columns, place a filter to list only those objects meeting the filter criteria or list the objects in a given order.

Note that the default “workbook.tbl” document is a table document providing an exhaustive view of all the data in your project.

1. Creating a Table Document in an Open Project

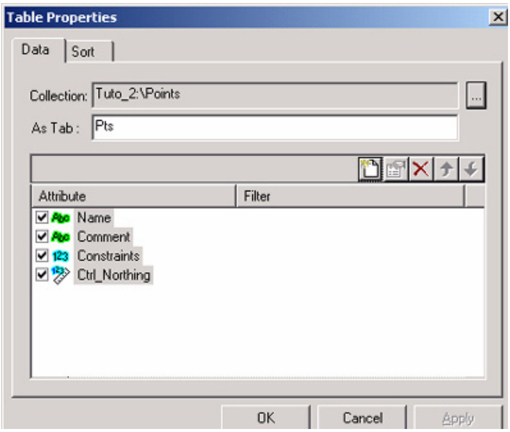
- Select **File>New** to open the New dialog box.
- On the **Documents** tab, select “Table” from the list. Name the new document by typing a name in the **File Name** field. For example, type in “Table1”. (Keep the other default choices: Active project prompted in the **Add to project** field; Blank **Folder** field means that the document will be saved in the active project folder.)
- Click **OK**. A new blank table document opens on the View pane. The table consists of a single tab named “sheet 1” (tab located at the bottom of the table document).
- To define the content of the document from the menu bar, select **Table>Tabs**. The **Table Properties** dialog opens.
- Click . This displays the **Data** tab in the **Table Properties** dialog box.
- Click ... (on the right of the **Collections** field) to select the collection from which you are going to define the content of this tab. For example, choose “Points” and click **OK**.

- In the **As Tab** field underneath, type a new name for the tab. For example type “Pts”:



- Click . The new dialog box that opens allows you to choose the attributes you wish to see in the table document. The default list shown in this table provides all the attributes that are not currently present in the table document. (You could also list all the possible attributes by checking the **Show all attributes** radio button.)

- To add a new attribute to the table document as a new column in the "Pts" tab, first select it in the list. You can select several attributes at a time by holding down the Shift or Ctrl key while clicking on the attributes. Once all the desired attributes are highlighted, click **Add**. The **Data** tab is now displayed listing all the selected attributes:



- If you want to add more attributes to the "Pts" tab, resume the previous two steps.
  Note that you can change the order in which the attributes are listed on the **Data** tab. To change the position of an attribute in the list:
  - Select it
  - Click  or  until the attribute is at the desired position. The first attribute in this list will appear in the first column and so on.
- When you are done with the attributes of the "Pt" tab, click **OK** to return to the **Tab** tab in the **Table Properties** dialog box.

- To create a new tab, click  and then resume the previous 6 steps.
- Once you have defined all your tabs, click **OK** to close the **Table Properties** dialog box. Your new table document is then updated to reflect all the changes made. Note that GNSS Solutions has automatically filled in the tables using the relevant data from the project database.

2. Removing an Attribute from a Table Document

Temporary removal:

- On the menu bar, select **Table>Data**. This opens the **Table Properties** dialog box.
- In the list of attributes, clear the check button opposite the name of the attribute to temporarily remove it from the table
- Click **OK**. This removes the selected column from the table.
  To re-enable this attribute in the table document, re-check this button.

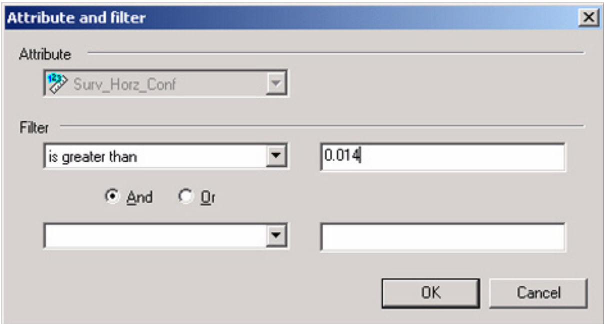
Normal removal:

- On the menu bar, select **Table>Data**. This opens the **Table Properties** dialog box.
- In the list of attributes, select the attribute you want to remove from the table document.
- Click . This deletes the attribute from the list.
- Click **OK**. This removes the corresponding column from the table.

3. Setting a Filter on an Attribute

Setting filters on attributes allows you to list only these objects in a table document that you are interested in viewing. The result of this operation is that the table document will contain fewer objects (fewer rows).

- On the menu bar, select **Table>Data**. This opens the **Table Properties** dialog box.
- In the list of attributes, select the attribute for which you want to set a filter. For example, select “Surv_Horz_Conf”.
- Click . In the dialog box that opens, make the following choices:

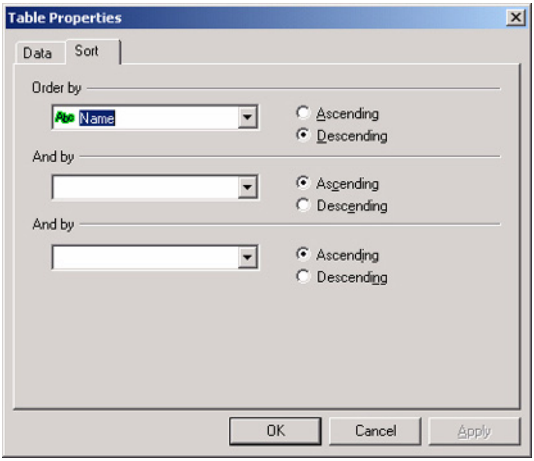


- Click **OK** (twice). The table document now only consists of a number of rows showing the objects meeting the filter criterion. This criterion is recalled in the corresponding cell just under the column header. Incidentally, if you click on this cell, GNSS Solutions will re-open the above dialog box.

4. Sorting Objects in a Table Document

You can sort the objects present in table documents according to your needs. This is explained below.

- Open the desired table document in the View pane and then click on the desired tab.
- On the menu bar, select **Table>Sort**. This opens the **Table Properties** dialog box showing the **Sort** tab.
- In the upper-left field, click on the down-arrow and then select the attribute on which object sorting will be based.
  Note that the choice of attributes in the drop-down menu attached to this field is not restricted to the set of attributes displayed in the table. Indeed, you can choose any attribute from the concerned collection.
- Once you have chosen the attribute, select the sorting direction by checking the corresponding button (**Ascending** or **Descending**) opposite the field.



- Through the same above 2 steps, you can define a second, even a third sorting attribute, with decreasing priority. They will take effect only if the higher-priority attribute fails to sort the objects. For example if the first (higher-priority) sorting attribute equals “25” for a number of objects in the table, then GNSS Solutions will use the second sorting attribute to sort these objects, etc.

5. Creating a Geocentric System for a Table Document

Geocentric systems are incompatible with maps and so, in GNSS Solutions, can only apply to table or graph documents. This is the reason why you cannot select a geocentric system at project level. To create a new geocentric system:

- Run the **Tools>Coordinate Systems** command
- Click , check the **Define a NEW GEOCENTRIC system** option and click the **Next** button.
- Complete the two screens allowing the definition of a geocentric system. Defining a geocentric system is much like defining a geographic system (see *Creating a Geographic System on page 127*) except that you do not have to define a vertical datum.

❑ Time Documents

Time documents are principally used to show observation files versus time. They are very useful in post-processing applications. It does not make sense to base the definition of a time document on any collection other than the dated collections, namely “Points”, “Files”, “Stops” and “vectors”.

Note that the default “Time view” document gives an exhaustive view of your observation files.

The first 5 buttons from the map toolbar can be used when a Time document is active in the View pane:

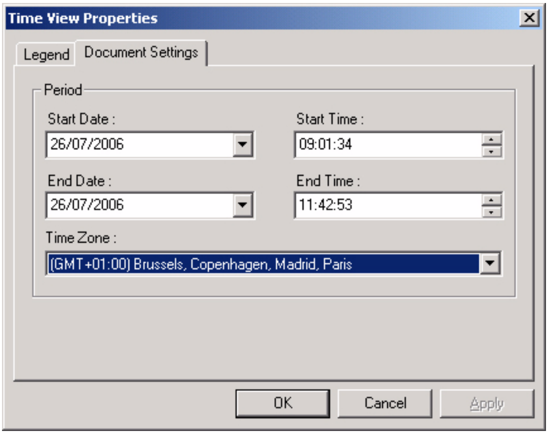
1. Creating a Time Document in an Open Project

- Open one of your projects containing field data to create a time document.
- Select **File>New** to open the **New** dialog box.
- On the **Documents** tab, select “Time” from the list. Name the new document by typing a name in the **File Name** field. For example, type in “Time1”. (Keep the other default choices: Active project prompted in the **Add to project** field; Blank **Folder** field means that the document will be saved in the active project folder.)
- Click **OK**. A new “blank” time document opens on the View pane.

2. Defining the X Axis of a Time Document

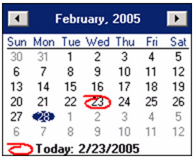
- On the menu bar, select **Time>Document Settings**. This opens the **Time View Properties** dialog box showing the content of the **Document Settings** tab.

  This tab defines the X axis of the time document (date & time at the origin + date & time at the end of the diagram). When you create a time document, GNSS Solutions analyzes the observation files present in the project and determines the period of time covered by these files. The 4 time parameters on the **Document Settings** tab are then automatically set to match this period of time.



  You can however edit these 4 parameters, plus the time zone, to meet your own needs. To change the start or end date, click on the corresponding down-arrow.

A calendar is then displayed:



- Click on the displayed year and use the up/down arrows next to it to set the year
- Click on the right/left arrow to set the month
- Click on the day number to set the day. This closes the calendar.

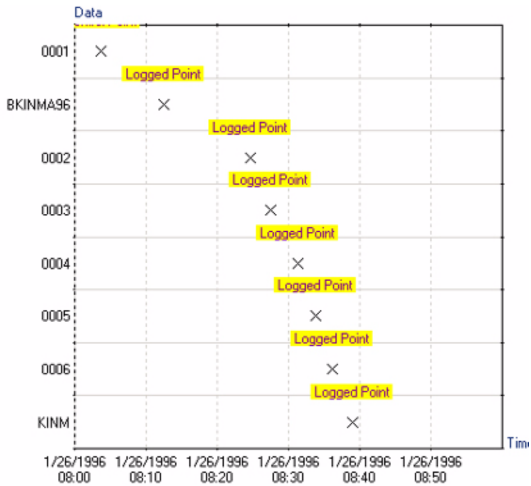
- When you agree with these parameters, click **OK** to close the dialog box.

3. Defining the Y Axis of a Time Document

You define the Y axis by adding layers to the legend, in the same way as you would in a map document.

- On the menu bar, select **Time>Legend**. This opens the **Time Diagram Properties** dialog box showing the content of the **Legend** tab.
- Click  to define the first layer. The new dialog box that opens allows you to specify the collection from which you want to define the layer.
- Select a dated collection (for example “Points”) and then click **OK**. This opens the **Layer Wizard: Data** dialog box.
- In the **PLOT** field, choose the data you want to use as the “graduation” along the Y axis. If you choose “Default”, then only the collection name will appear along the Y axis. For example, select “Name” in the **PLOT** field and then click **Next>**. This opens the **Layer Wizard: Style** dialog box.

- You can now define the style of the objects that will be plotted in the time diagram. For example select “Type” from the drop-down menu associated with the **Text** field. This menu lists all the attributes of the Points collection you have selected in a previous step.
- Then freely choose any style that you would like to apply to this object (text color, background color, position and symbol).
- Click on the **Finish** button and then on the **OK** button. The time document is now displayed in the View pane (see example below).



This view shows how and when each point was surveyed. Note that you can create several layers and apply filters to your layers, in the same way as you would in a map document.

❑ Graph Documents

You need to have a table document open on the View pane to create a graph in a graph document. Open one of your projects including field data and a map document.

1. Creating a Graph Document in an Open Project

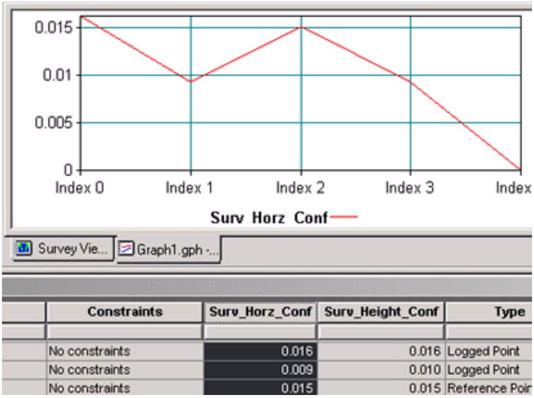
- On the menu bar, select **File>New**
- Select "Graph" on the **Documents** tab. Name the new document by typing a name in the **File Name** field, for example, type "Graph1".
- Click **OK**. A new blank graph document opens on the View pane.

2. Defining the X and Y Axes

Select one or two columns in the workbook that you want to represent on the graph. If the second column is not adjacent to the first one, press the Ctrl key before clicking on the header of this column. If you select a single column, then its content will be used to define the Y-axis and a dimensionless, linear scale will be used as default setting on the X-axis.

- In the **Workbook** document, select the **Surv_Horz_Conf** column by clicking in the column header
- Drag and drop the column header in the Graph document.

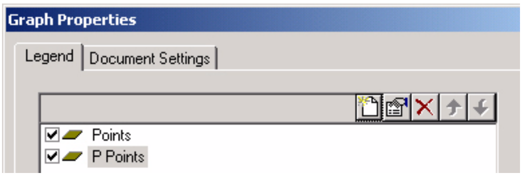
A graph now appears in the graph document, as shown below:



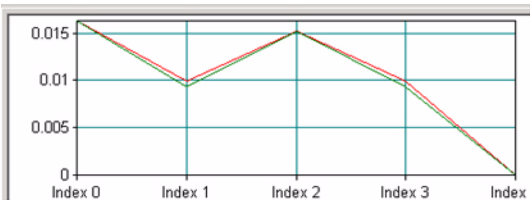
3. Adding a new curve on the same graph

- Right-click anywhere within the graph document and select **Legend** in the pop-up menu. The **Graph Properties** dialog box opens.
- On the **Legend** tab, click 
- Select "Surv_Height_Conf" in the **PLOT** field (located in the **Data** area at the bottom of the dialog box)

- Click **OK**. The **Graph Properties** dialog box now shows two items on the **Legend** tab:

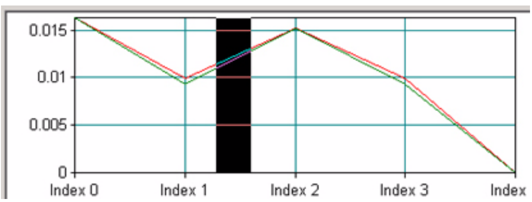


- Click **OK**. Two curves are now plotted on the graph with different colors: one for the horizontal precision, the other one for the height precision. Both use the same X axis.

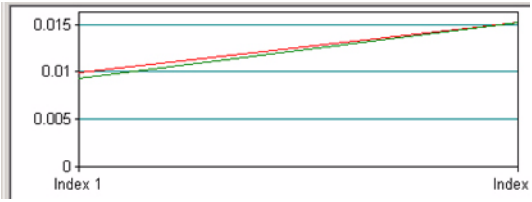


4. Zooming in on a Graph

- Drag horizontally (along the X axis) on the graph. The selection resulting from the drag operation appears in black:



- When you release the mouse button, GNSS Solutions zooms in on the selected region in order to show this region using the total width of the graph document:



- To come back to normal size, right-click anywhere on the graph document and select **Zoom Out** on the pop-up menu.
- Click **OK** to close this dialog box and enable the new coordinate system. The map is then updated to reflect the change made.

To change the coordinate system used in the active table document:

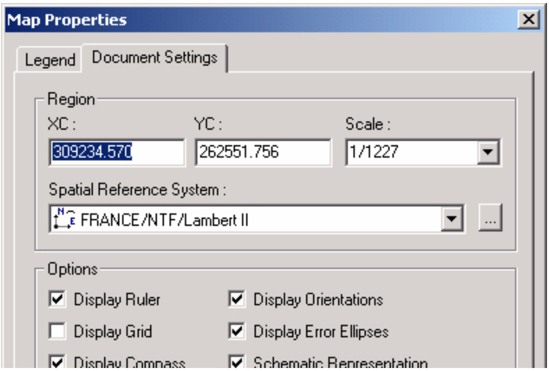
- Right click anywhere on the table and select **Document Settings** in the menu that pops up. The **Document Settings** dialog box opens.
- Select the desired system from the list attached to the **Spatial Reference System** field (a combo box). Note that you can also change the time zone.
- Click **OK** to close this dialog box and enable the new coordinate system. The table is then updated to reflect the change made.

❑ Selecting a Coordinate System in a Table or Map Document

You can choose a specific coordinate system for any document, whether a table or map document, without affecting the choice you have made for the whole project. On the other hand, as long as you do not specify anything else, any document that you create in a project will by default use the coordinate system chosen for the project.

To change the coordinate system used in the active map document:

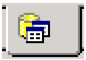
- Right click anywhere within the map document and select **Document Settings** in the menu that pops up. The **Document Settings** dialog box opens. This box shows the coordinates of the central point on the map as well as the scale currently used. See example below:



- Select the desired system from the list attached to the **Spatial Reference System** field (a combo box). Note that you can also change the map viewing options from this dialog box, as explained in *Changing the Viewing Settings on page 19*.

❑ Combining Data from Different Projects

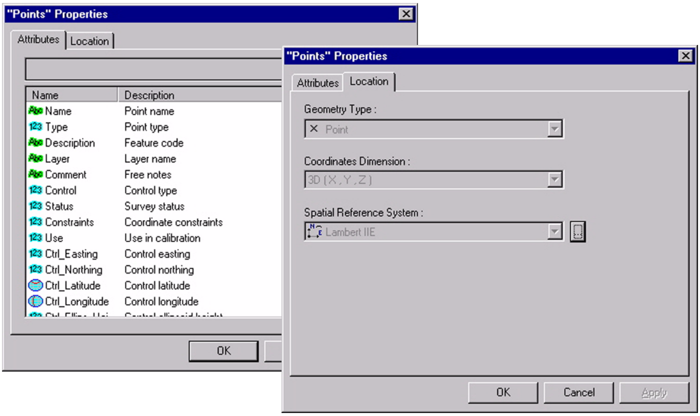
When the open workspace contains several projects, you can create a map document in one of the projects (the active project) gathering objects from different projects in the workspace.

1. Open the workspace
2. Choose a project in the workspace to be the active project by selecting **Project>Set Active Project>[Project_Name]**.
3. Using the **File>New** command, select the **Documents** tab, choose **Map**, name the new document and click **OK** to create a new map document. This document opens in the main window.
4. Click on  (Collections tab) in the Workspace pane. This tab shows the collections of all projects in the workspace pane. Note that the name of the active project is shown in bold characters.
5. *Drag* a collection from one of these projects into the open map document. The mouse cursor is changed into a “+” symbol while dragging. Release the mouse button when the cursor is inside the document. A new dialog opens asking you to apply a filter to the collection. Applying a filter at this stage is as explained in *Adding a New Layer to a Map Document on page 179*.
6. Then click **Next>**. A new dialog opens asking you to define a style to the collection. Defining a style at this stage is as explained in *Adding a New Layer to a Map Document on page 179*.
7. Click **Finish**. All objects from the collection that meet the filter criteria appear in the map document and are represented according to the style you have defined.
8. Resume Steps 5 to 7 to insert a collection from another project into the same map document. As a result the map document shows data from two different projects. Note that this map document stays attached to the project that was active when you created it.

❑ Editing the Definition of a Collection

To list the attributes characterizing any of the objects present in a collection, do the following:

- Right-click on a collection, select **Properties** on the popup menu, or double-click directly on the collection. The two tabs below show the attributes of a point object (general case).



The first tab lists all the classic attributes (“one-dimensional” text, numeric or Boolean type). The second one shows the geometric attribute (“multi-dimensional”).

There are three possible types of geometric attributes:

- Point, defined by a set of coordinates expressed on a specific coordinate system
- Line, defined by two or more sets of coordinates expressed on a specific coordinate system
- Area, defined by a close line.

See *Database Collections on page 203* where all possible collections in a project are reviewed. All attributes pertaining to each of these collections are also listed.

❑ Database Collections

Files Collection

Each object in this collection is of the geometric type (3D point expressed in a specified coordinate system) and also has the following classic attributes:

Name	File name
Full_Path	Ashtech file full path name
Source	Source file format
Start_Time	Time of first record
Time_Span	Record duration
Sampling	Sampling interval (s)
Epochs	Count of records
Size	File size (KB)
Meas_Type	Measurement type
Antenna_Type	Antenna model used for data collection
Antenna_Height	Default antenna height
Height_Type	Default antenna height type
Site	Default site name
Dynamic	Indicates whether the receiver has been moved during recording
Receiver_Type	Type of used receiver
Receiver_Number	Serial number of used receiver
Satellites	Available satellites

Processes Collection

Each object in this collection is of the geometric type (3D line expressed in a specified coordinate system) and also has the following classic attributes:

Num	Process number in process scenario
Reference	Reference site (used to get reference position)
Reference_File	Reference file
Rover	Rover site (used to store process results)
Rover_File	Rover File
Mode	Processing mode
Min_Elevation	Satellite elevation under which data must be rejected
Deselected	Satellites that must be excluded in any case
Forbidden_Reference	Satellites that can't be used as reference
Mask	Measurements that must be excluded from process
Orbit_Type	Orbit type
L1L2	Indicates whether L2 data have to be process or not
Fix_Integers	Indicates whether process have to fix integers or not
Done	Indicates whether process has been executed or not

Events Collection

Each object in the collection has the following attributes:

Point	Associated point name
Description	Associated point feature code
Time_Tag	Time of event
File	Raw data file
Receiver_Type	Type of receiver used
Receiver _Number	Serial number of receiver used

Occupations Collection

Each object in the collection has the following attributes:

Site	Occupied site name
Description	Feature code of occupied site
Start_Time	Start time of occupation
Time_Span	Time span of occupation
File	Raw data file
Antenna_Height	Antenna height during occupation
Height_Type	Antenna height type
Init_On_Bar	Kinematic initialization point using initializer bar
Dynamic	Indicates whether the receiver moved during the occupation
Receiver_Type	Type of receiver used
Receiver_Number	Serial number of receiver used

Areas Collection

Each object in this collection is of the geometric type (3D area expressed in a specified coordinate system) and also has the following classic attributes:

Name	Area name
Description	Feature code
Layer	Layer name
Comment	Free notes
2D_Length	Area 2D-perimeter
3D_Length	Area 3D-perimeter
Area	Surface area

Lines Collection

Each object in this collection is of the geometric type (3D line expressed in a specified coordinate system) and also has the following classic attributes:

Name	Line name
Description	Feature code
Layer	Layer name
Comment	Free notes
2D_Length	Line 2D-length
3D_Length	Line 3D-length

Points Collection

Each object in this collection is of the geometric type (3D point expressed in a specified coordinate system) and also has the following attributes:

Name	Point name
Type	Point type
Description	Feature code
Layer	Layer name
Comment	Free notes
Control	Control type
Status	Survey status
Constraints	Coordinate constraints
Use	Use in calibration
Ctrl_Easting	Control easting
Ctrl_Northing	Control northing
Ctrl_Latitude	Control latitude
Ctrl_Longitude	Control longitude
Ctrl_Ellips_Height	Control ellipsoid height
Ctrl_Ortho_Height	Control orthometric height
Ctrl_Easting_Sd	Control easting standard deviation
Ctrl_Northing_Sd	Control northing standard deviation
Ctrl_Height_Sd	Control height standard deviation
Ctrl_Easting_Conf	Control easting confidence (95%)
Ctrl_Northing_Conf	Control northing confidence (95%)
Ctrl_Horz_Conf	Control horizontal confidence (95%)
Ctrl_Height_Conf	Control height confidence (95%)
Ctrl_Easting_Error	Control easting error
Ctrl_Northing_Error	Control northing error
Ctrl_Horz_Error	Control horizontal error
Ctrl_Height_Error	Control height error
Ctrl_Total_Error	Control error according to control type
Ctrl_QA	Control quality assurance test passed
Surv_Time	Surveyed position time
Surv_Easting	Surveyed easting
Surv_Northing	Surveyed northing
Surv_Latitude	Surveyed latitude
Surv_Longitude	Surveyed longitude
Surv_Ellips_Height	Surveyed ellipsoid height
Surv_Ortho_Height	Surveyed orthometric height
Surv_Easting_Sd	Surveyed easting standard deviation

Surv_Northing_Sd	Surveyed northing standard deviation
Surv_Height_Sd	Surveyed height standard deviation
Surv_Easting_Conf	Surveyed easting confidence (95%)
Surv_Northing_Conf	Surveyed northing confidence (95%)
Surv_Horz_Conf	Surveyed horizontal confidence (95%)
Surv_Height_Conf	Surveyed height confidence (95%)
Surv_EN_Corr	Surveyed easting / northing correlation
Surv_EH_Corr	Surveyed easting / height correlation
Surv_NH_Corr	Surveyed northing / height correlation
Convergence	Grid convergence angle for this point
Scale_Factor	Grid scale factor for this point
Elevation_Factor	Distance reducing factor to the surface of the ellipsoid
P1P	Distance between P1 and P
P2P	Distance between P2 and P
Side	Lateral offset side
Warning	Indicates there are warnings (check Message for more info)
Message	System message

Vectors Collection

Each object in this collection is of the geometric type (3D line expressed in a specified coordinate system) and also has the following classic attributes:

Reference	From point
Rover	To point
Start_Time	Time of vector (start time of occupation)
Time_Span	Time span of occupation
Solution	Processed solution type
Proc_QA	Quality Assurance test passed for processed solution
Proc_DX	Processed ECEF WGS84 DX component
Proc_DY	Processed ECEF WGS84 DY component
Proc_DZ	Processed ECEF WGS84 DZ component
Proc_Length	Processed length
Proc_DX_Sd	Processed ECEF WGS84 DX standard deviation
Proc_DY_Sd	Processed ECEF WGS84 DY standard deviation
Proc_DZ_Sd	Processed ECEF WGS84 DZ standard deviation
Proc_Length_Sd	Processed length standard deviation
Proc_DX_Conf	Processed ECEF WGS84 DX confidence (95%)
Proc_DY_Conf	Processed ECEF WGS84 DY confidence (95%)
Proc_DZ_Conf	Processed ECEF WGS84 DZ confidence (95%)

Proc_Length_Conf	Processed length confidence (95%)
Proc_DXY_Corr	Processed ECEF WGS84 DX / DY correlation
Proc_DXZ_Corr	Processed ECEF WGS84 DX / DZ correlation
Proc_DYZ_Corr	Processed ECEF WGS84 DY / DZ correlation
Dynamic	Indicates whether vector has been processed in dynamic mode
SVs	Count of satellites during process
PDOP	PDOP during process
Meas_Type	Measurement type
Epochs	Count of records used
Enabled	Indicates whether solution is to be kept for adjusment
Adjusted	Indicates whether this vector has been adjusted
Adj_QA	Quality Assurance test passed for adjusted solution
Adj_DX	Adjusted ECEF WGS84 DX component
Adj_DY	Adjusted ECEF WGS84 DY component
Adj_DZ	Adjusted ECEF WGS84 DZ component
Adj_Length	Adjusted length
Adj_DX_Sd	Adjusted ECEF WGS84 DX standard deviation
Adj_DY_Sd	Adjusted ECEF WGS84 DY standard deviation
Adj_DZ_Sd	Adjusted ECEF WGS84 DZ standard deviation
Adj_Length_Sd	Adjusted length standard deviation
Adj_DX_Conf	Adjusted ECEF WGS84 DX confidence (95%)
Adj_DY_Conf	Adjusted ECEF WGS84 DY confidence (95%)
Adj_DZ_Conf	Adjusted ECEF WGS84 DZ confidence (95%)
Adj_Length_Conf	Adjusted length confidence (95%)
Adj_DXY_Corr	Adjusted ECEF WGS84 DX / DY correlation
Adj_DXZ_Corr	Adjusted ECEF WGS84 DX / DZ correlation
Adj_DYZ_Corr	Adjusted ECEF WGS84 DY / DZ correlation
DX_Residual	ECEF WGS84 DX component residual
DY_Residual	ECEF WGS84 DY component residual
DZ_Residual	ECEF WGS84 DZ component residual
Length_Residual	Total residual on vector length
Tau_Test	Tau test passed

Repeat Vectors Collection

From	From point
To	To point
Observation1	Time of first vector (start time of occupation)
Observation2	Time of second vector (start time of occupation)
QA	Vector quality assurance test passed
Length	Processed length
Diff_X	DX component gap
Diff_Y	DY component gap
Diff_Z	DZ component gap
Diff_Length	Length gap
Diff_X_PPM	DX component gap in ppm
Diff_Y_PPM	DY component gap in ppm
Diff_Z_PPM	DZ component gap in ppm
Diff_Length_PPM	Length gap in ppm
Diff_X_Ratio	DX component gap ratio
Diff_Y_Ratio	DY component gap ratio
Diff_Z_Ratio	DZ component gap ratio
Diff_Length_Ratio	Length gap ratio

Loop Collection

Loop	Loop number
Loop_Length	Total loop length
X_Miscl	DX component misclosure
Y_Miscl	DY component misclosure
Z_Miscl	DZ component misclosure
Length_Miscl	Total misclosure
X_Miscl_PPM	DX component misclosure in PPM
Y_Miscl_PPM	DY component misclosure in PPM
Z_Miscl_PPM	DZ component misclosure in PPM
Length_Miscl_PPM	Total misclosure in PPM
X_Miscl_Ratio	DX component misclosure ratio
Y_Miscl_Ratio	DY component misclosure ratio
Z_Miscl_Ratio	DZ component misclosure ratio
Length_Miscl_Ratio	Total misclosure ratio

CAD Function

See Introductory Notes at the beginning of chapter *Advanced Features on page 167*.

❑ Enabling the CAD Function

- Select **Tools>Preferences**
- Check the **Show CAD functions** option
- Click **OK** to close the Preferences window. This makes the CAD feature now available for use.

❑ Creating a Project With the CAD Option Enabled

CAD projects are created exactly in the same way as post-processing projects (see *Creating a New Project on page 35*). The only difference is the presence in CAD projects of an additional tab named "Feature Code List" in the project settings, as is also the case in RTK projects (see *Creating a real-time (RTK) Project on page 162*)

This tab allows you to define a list of feature codes for the project. Feature codes give information on the geometry of features. For example a point will be defined as being part of a line if the feature code assigned to it refers to a line.

If you edit the points in your project and assign a feature code to each of them, GNSS Solutions will be able to draw automatically lines or areas connecting the points having the same feature code.

Any list of feature codes can be saved as an FCL or TXT file.

❑ Manually Drawing Lines and Areas

Lines:

On the map toolbar:

- Select **<Project_Name> \ Lines** in the combo box
- Click 
- Start drawing the line on the map by clicking on the start point, then at the end of each new segment forming the line
- To end the line, double-click the last point.
- In the dialog box that opens, complete the fields defining the line (on the **Line** tab) and then click **OK** to close the dialog box. The new line then appears on the map. Its representation relies on the definition of the *layer* this line belongs to.

Areas:

On the map toolbar:

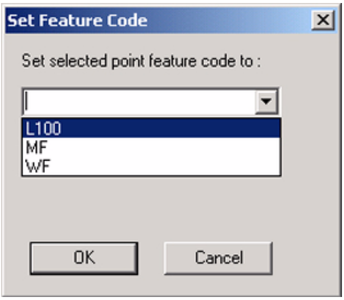
- Select **<Project_Name> \ Areas** in the combo box
- Click 
- Start drawing the limits of the area by clicking on the start point, then at the end of each new segment forming the area.
- Double-click on the map to close the area. If you double-click on a point other than the area's start point, GNSS Solutions will automatically create the missing segment allowing it to close the geometric figure.
- In the dialog box that opens, complete the fields defining the area (on the **Line** tab) and then click **OK** to close the dialog box. The new area then appears on the map. Its representation relies on the definition of the *layer* this area belongs to.

❑ Assigning Layer Names To Points (Setting Feature Codes)

Use the Design View to see the changes you make when assigning feature codes to your points. The reason is that the legend of this default document is automatically completed every time you add a new feature code to the project. For example, if you add a new feature code named “fence”, then GNSS Solutions will create new layers in the Design View’s legend named “fence_Points”, “fence_Lines” and “fence_Areas”.

You can assign a feature code to one or more points by doing the following:

- Select the desired points on the Design View map document or in any other open document
- Click on the **CAD** topic bar in the workspace pane, and then on the **Set Feature Codes** icon. A dialog then prompts you to assign one of the feature codes defined in the project to the selected points (see example below):



- Select the desired feature code, click **OK** and then select:
  - **To Apply** if you simply want to assign the feature code to the selected points. This feature code will then appear as the **Description** parameter in the properties of each of these points (see *Point Properties on page 77*)
  - **To Apply and Process** if you also want GNSS Solutions to re-process the feature codes to build objects (lines or areas).

The **Description** *field is intentionally named "Description" not "Code" because this field can freely be assigned any value other than one of the codes from the Feature Code List tab.*

❑ Processing Feature Codes

This function allows GNSS Solutions to draw lines and create areas between the different points to which you have previously assigned feature codes.

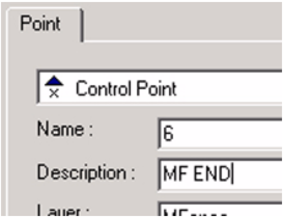
You do not need to select anything in your project. GNSS Solutions will analyze all the feature codes assigned to your points and will automatically draw lines/ areas between the different points.

- To run this function, click on the **CAD** topic bar and then on the **Process Feature Codes** icon. For a given set of points defined with the same "line" feature code, GNSS Solutions will always draw lines from the oldest to the newest point (and so the program will ignore the order in which you may have selected these points before running the function).

Ending a line

To end a line at a given point:

- Select this point in the Design View, right-click and select **Properties** (in the pop-up menu)
- In the dialog box that opens, type in “END”, in the **Description** field, after the already present string (see example below; don’t forget the space before “END”) and then click **OK**.



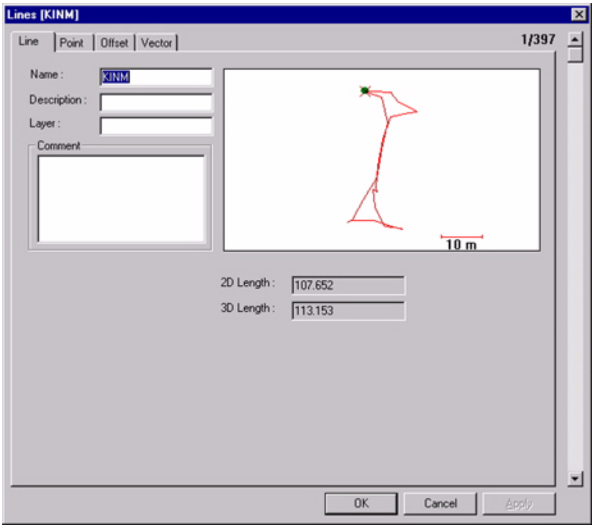
- Click on the **Process Feature Codes** icon in the Workspace pane to re-run the Process Feature Code function. The polyline will now end at the specified point, as shown in the Design View.

Creating an area

To create an area from a polyline:

- Select the end point of the polyline, right-click and select **Properties** (in the pop-up menu)
- In the dialog box that opens, overwrite “END” with “CLO” in the **Description** field and then click **OK**.
- Click on the **Process Feature Codes** icon in the Workspace pane to re-run the Process Feature Code function. The polyline will now be changed into an area, as shown in the Design View.

❑ Editing a Line



The properties of a line (i.e. a trajectory or polyline) are presented on a 4-tab dialog box (see above). To open this box, double-click a line displayed in the active map document. The **Line** tab contains the following information:

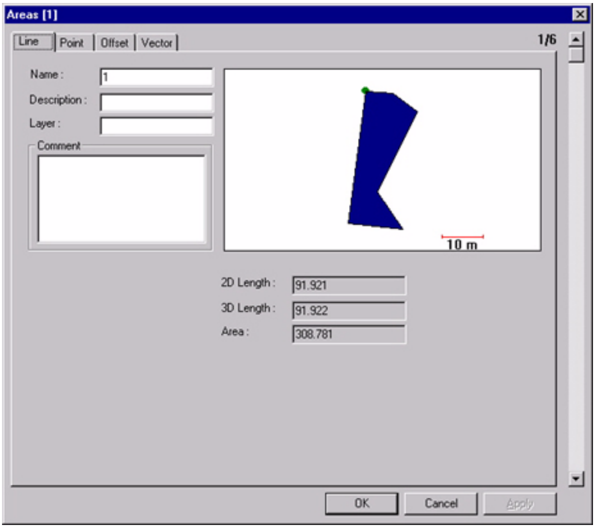
- Name and description of the line, name of the layer the line belongs to + comment
- A graphic view of the line showing its geometry and the location of the point currently selected on the **Point** tab
- The total length of the line, measured in two dimensions (projected onto horizontal plane) and in three dimensions (i.e. taking into account the individual height of each of the points making up the line).

The **Point** tab shows the properties of each of the points making up the line. Use the vertical scroll bar to browse through the list of points.

The **Offset** tab shows the pivot points when the point selected on the **Point** tab was surveyed through an offset method (6000 & 6500 only).

The **Vector** tab shows the properties of all the vectors from which the survey of the line proceeds. Use the vertical scroll bar to browse through the vectors list. Each vector connects the reference point to each of the points forming the line.

❑ Editing an Area



The properties of an area are presented on a four-tab dialog box (see above). To open this box, double-click an area displayed in the active map document.

The **Line** tab contains the following information:

- Name and description of the area, name of the layer the area belongs to + comment
- A graphic view of the area showing its geometry and the location of the point currently selected on the **Point** tab
- The perimeter of the area, in the selected unit, measured on the horizontal plane (2D) and in three dimensions (3D) + area, in the selected unit, projected onto horizontal plane (2D)

The **Point** tab shows the properties of each point making up the area. Use the vertical scroll bar to browse through the list of points.

The **Offset** tab shows the pivot points when the point selected on the **Point** tab was surveyed through an offset method (6000 & 6500 only).

The **Vector** tab shows the properties of all the vectors from which the survey of the area proceeds. Use the vertical scroll bar to browse through the vectors list. Each vector connects the reference point to each of the points forming the area.

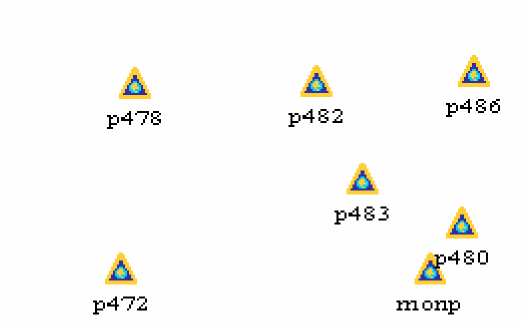
Use the Project>Group Points function to create an area from existing points. ❑

Chapter 13:Corrections Providers & Reference Stations

Introduction

For every project created in GNSS Solutions, the Survey View will show the locations of reference stations present around your working area so you can use them at your convenience when post-processing your field data.

Reference stations are represented on the Survey View as blue and yellow triangles (see below) with the first four characters of the station name displayed nearby.

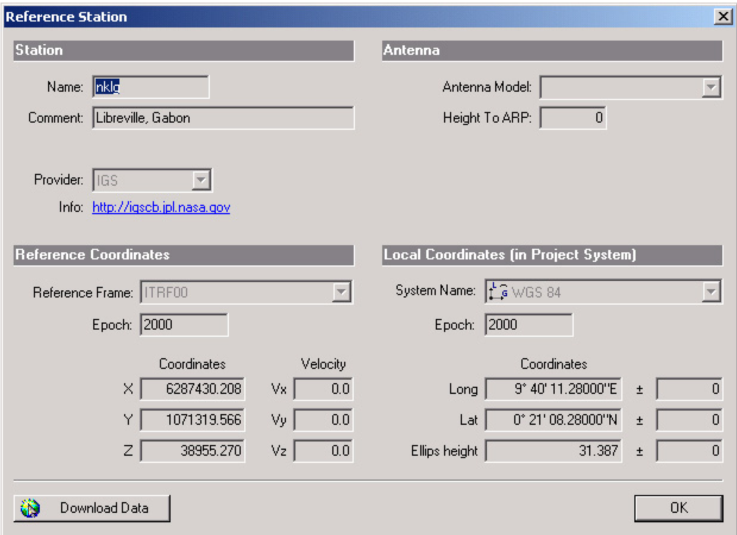


When a project is still empty, you will notice that the Survey View does not show any reference station. This is because the default zoom setting in this case does not allow it. But if you zoom out repeatedly on this view, you will progressively see more and more stations.

As can be seen on the Survey View when completely zoomed out, reference stations can be found everywhere on all continents, with more or less dense networks depending on countries.

Editing the Properties of a Reference Station

- In the map toolbar, click on 
- Double-click on any of the reference station icons shown in the Survey View. This opens a dialog box showing the properties of the station. The following information is provided: Station name, provider, antenna model,reference coordinates (on ITRF), local coordinates in the open project’s coordinate system, etc. None of these parameters is editable.



The meaning of each of the parameters shown in this dialog is provided in *Adding New Reference Stations on page 224*.

Adding a New Provider

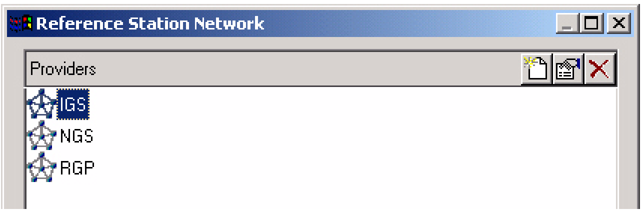
You can add providers to GNSS Solutions using the procedure described below. New providers will add up to the list of default providers.

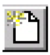
Defining a provider is a three-step operation:

- First you will name the provider and optionally specify additional information (comment, web site).
- Secondly, you will define the type, or types, of data offered by this provider.
- Finally, you will define one or more reference stations through which the provider makes its services available. The parameters of a reference station can be defined:
  - Either by entering each of these parameters in the dedicated dialog box
  - Or, more easily, by importing a file containing all these pararameters.

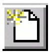
❑ Identifying the New Provider

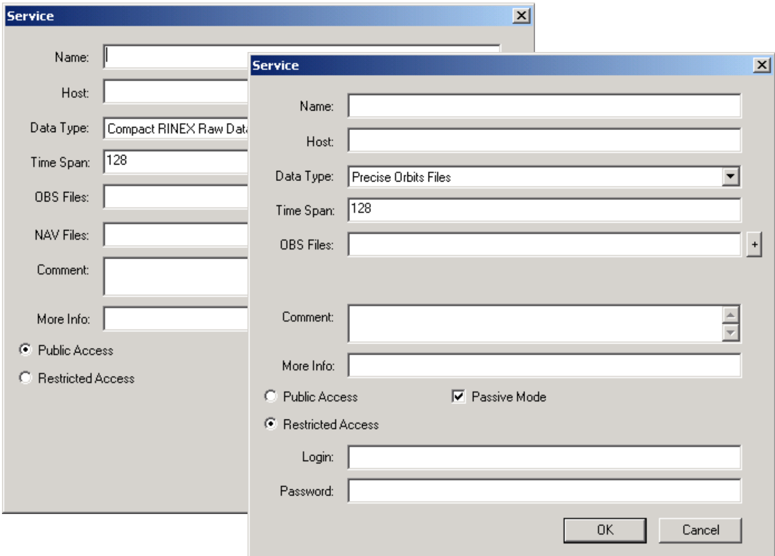
- From the menu bar, select **Tools>Station Reference Network**. This opens a new dialog box showing the default providers.



- Click on  in the upper-right corner of the Reference Station Network window. This opens a three-tab Properties dialog box.
- Click on the **Description** tab and then enter the following parameters:
  - **Name**: Provider name (mandatory)
  - **Comment**: More information about the provider (optional)
  - **Info**: Web site giving more information on this provider (optional)

❑ Defining the Provider Services

- Click on the **Services** tab and then click  in the upper-right corner of the window to enter a new service. Note that the dialog box then appearing (see below) will be slightly different depending on whether you want the new service to provide raw or precise orbit data, precise clock data or precise iono data, and the access to the web site is public or restricted.



This dialog box is organized, and should therefore be used, as follows:

- **Name**: Enter the service name or any other information relevant to the desired service. For example enter "Raw Data"
- **Host**: Enter the web address from which to download
- **Data Type**: Choose the type of data delivered by this service (standard RINEX raw data, compact RINEX raw data or precise orbit data, precise clock data or precise iono data).

- **Time Span**: GNSS Solutions needs to know the period of time covered by any of the files delivered by this service. Enter this time in minutes. Ask your provider or consult its website if you do not know this value.
- **OBS Files**: GNSS Solutions needs to know where the files are stored on the provider's website and how they are named. You should then enter the path to files (example: /pub/gps/rawdata) followed by the syntax used in the filenames. The "+" button located on the right of this field allows you enter this syntax in a more friendly way. Ask your provider or consult its website if you do not know the path and the syntax of filenames.
- **NAV files**: Same as **OBS files** field above. You will not have to complete this field if the selected data type is "Precise Orbit Files".

  NOTE: If the provider delivers its observation and navigation data in the same zip file, then the same path should be specified in the "OBS Files" and "NAV Files" fields.
- **Comment**: Enter your personal notes regarding the service (optional)
- **More Info**: For example, use this field to enter the address of a particular page on the provider's web site.
- **Public/Restricted Access** radio buttons: Choose the appropriate option. If you check **Restricted Access**, then you will have to enter a username and a password in the next two fields.
- **Log in**: If you have checked **Restricted Access**, enter the username normally supplied by the provider to access the specified website
- **Password**: If you have checked **Restricted Access**, enter the password normally supplied by the provider to access the specified website.

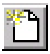
- Click **OK** to save the service you have just defined. This closes the dialog box and takes you back to the previous dialog box where you can see the list of existing services defined for this provider.

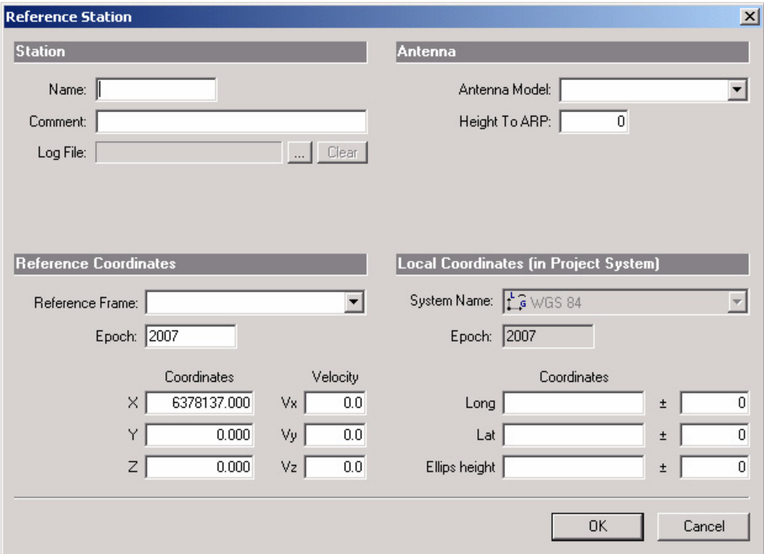
- To create a new service, click  again and resume the above instructions.

❑ Adding New Reference Stations

- Click on the **Stations** tab. You can define a new reference station either by entering each of its parameters or by importing a file containing the complete description of the station.

Manual Entry:

- Click on  in the upper-right corner of the dialog box and then enter the station parameters in the Reference Station dialog box.



Station pane:

- **Name**: Enter the name of the reference station.
- **Comment**: Enter any useful information relevant to the station (country, town where it's located).

- **Log File**: Use the Browse button next to the field to find the log file corresponding to the station you are defining. This implies that the log file should have been saved somewhere on your computer beforehand. Log files are usually available from provider web sites. See *Linking a Reference Station's Log File to its Properties Dialog Box on page 228* for more information. Once you have chosen the log file, you will be able to open it directly from this dialog by simply clicking on the blue file name mentioned in this field. If you wish to remove the link to the specified file, just click the **Clear** button next to the field.

Antenna pane:
- **Antenna Model**: Select the antenna model used at the station from the drop-down list.
- **Height to ARP**: Height, in meters, from the ground to the Antenna Reference Point (ARP).

Reference Coordinates pane:
- **Reference Frame** and **Epoch**: The position of the reference station should be expressed in a given ITRF (ITRF=International Terrestrial Reference Frame).

  All existing ITRF's are geocentric systems, the center of mass being defined for the whole Earth, including oceans and atmosphere.

  ITRFs evolve in time because they take into account the tectonic motions of the Earth. This is the reason why, when selecting an ITRF, you also have to indicate the time when the position of the reference station was determined on that ITRF. You have to enter this time in the **Epoch** field, just underneath. Basically, you have to enter the year of measurement (e.g. "2000"), but you may also be more accurate on the measurement time by entering a decimal figure (e.g. if you enter "2000.5", this means the station position was determined in June 2000).

  The following IRTFs are available in GNSS Solutions: ITRF00, ITRF92, ITRF93, RGF93, ITRF94, ITRF96, ITRF97 and NAD83 (CORS96). New models can be created in relation to ITRF00 (see *Adding a New Terrestrial Reference Frame on page 229*).

- **Coordinates** and **Velocity**: Use these fields to enter the accurate position of the station, as defined on the chosen reference frame. **Velocity** fields are all "0.0" by default.

Local Coordinates (..) pane:

- **System Name** and **Epoch**: Non editable fields; show respectively the currently selected coordinate system in the open project and the current year.
- **Coordinates**: These fields, which also provide the 3-D coordinates of the reference station, result from the transformation of the coordinates entered in the **Reference Coordinates** pane into the coordinate system used in the project.

- Click **OK**. The name of the station is now listed in the **Stations** tab.
- Click **OK** to complete the "Add Provider" procedure. The new provider is now listed in the Reference Station Network window.
- Click  to close this window.

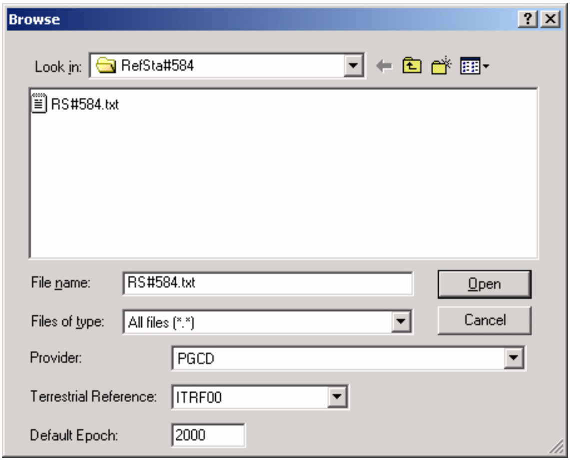
By importing a File:

It is assumed that a text file containing all the station parameters is available for use and you know how the parameters are arranged in the file (i.e. you know which data format is used in the file).

- On the **Stations** tab, click  in the upper-right corner of the dialog box.
- Choose the data format that the file to import complies with. The default formats are those of the default providers, namely IGS, NGS and RGP. If none of these formats is suitable, create a new one.

  To create a new format, click . For more information on how to create a custom format, refer to *Creating Custom Formats on page 154*.

- Click **OK** and then browse your computer to find and select the file to import. See example below where the new provider name is “PGCD”.



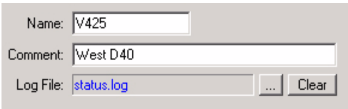
- Select the terrestrial reference and the default epoch corresponding to the station coordinates provided in the file (see definitions on page 225). The time you enter as “Default Epoch” will be used only if the imported file does not contain this information. If the file includes the Epoch information, this information will be used in priority and the one you entered will be discarded.
- Click the **Open** button. GNSS Solutions imports the file and then analyzes its content. When the file analysis is complete and successful, the name of the station appears in the **Stations** tab.
- Click **OK** to complete the “Add Provider” procedure. The new provider is now listed in the Reference Station Network window.
- Click  to close this window.

Linking a Reference Station's Log File to its Properties Dialog Box

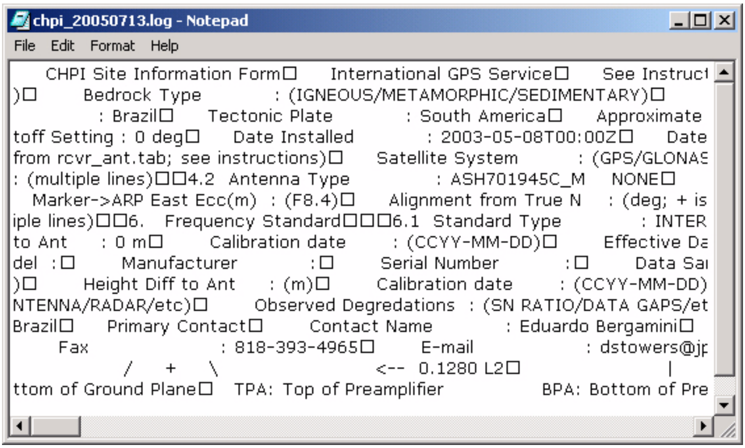
Providers usually post station description files (*.log files) on their web sites so you can download them if necessary. Log files provide a large amount of information about the station (provider, detailed inventory of equipment used and their specifications, contact information, etc.).

GNSS Solutions lets you create a link, from the properties dialog box of each station, to the corresponding log file saved on the hard disk. By doing this, you can easily view the file from the station's properties dialog box without having to remember where you put the file on your computer.

After you have created the link, you can open the log file by simply clicking on the log file name in the reference station properties dialog box.

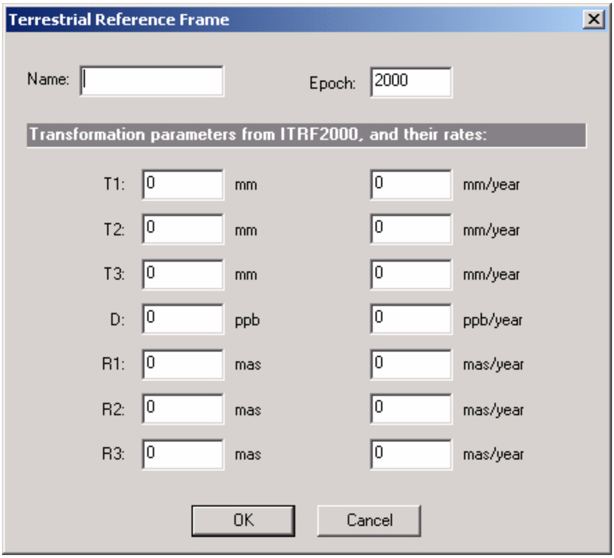


An example of what a log file looks like, when opened from the Properties dialog box, is presented below.



Adding a New Terrestrial Reference Frame

1. From the GNSS Solutions menu bar, select **Tools>Terrestrial Reference Frames..**
2. Click  in the upper right corner of the Terrestrial Reference Frames window.
3. Enter the following parameters to define a new terrestrial reference frame:



Parameter	Definition
Name	TRF name
Epoch	Reference epoch

Parameter	Value	Variation
T1	Delta x, in millimeters (mm)	in mm/year
T2	Delta y, in millimeters (mm)	in mm/year
T3	Delta z, in millimeters (mm)	in mm/year
D	Scale factor deviation, in ppb (in parts per billion)	in parts per billion/year
R1	Delta x rotation, in milliarcseconds (mas)	in milliarcseconds/year
R2	Delta y rotation, in milliarcseconds (mas)	in milliarcseconds/year
R3	Delta z rotation, in milliarcseconds (mas)	in milliarcseconds/year

4. Click **OK** to create the new TRF.

NOTE: To edit an existing TRF model, click  after highlighting the model name in the list.
For more information about the TRF models, go to http://www.iers.org/MainDisp.csl?pid=42-17 or http://itrf.ensg.ign.fr/ITRF_solutions/index.php.

Chapter 14: VRS Data Processing

This chapter is a supplement to *Chapter 4: Adding Data Files to a Project on page 49* and *Chapter 5: Data Processing on page 65*.

Introduction to VRS

The VRS processing is more particularly intended for single-frequency receivers, such as the ProMark3, when operated at a fairly long-distance from the network of closest reference stations. In this case, the VRS processing will allow GNSS Solutions to deliver a fixed solution more easily and with less observation data than would be obtained through conventional post-processing using the closest base station.

In GNSS Solutions, VRS (for *Virtual Reference Station*) is a process used to generate a base raw data file, called "VRS" raw data file, for a particular control point or observation file in your project.

When you ask GNSS Solutions to compute a VRS raw data file, it's as if you were creating a virtual reference station at the chosen location.

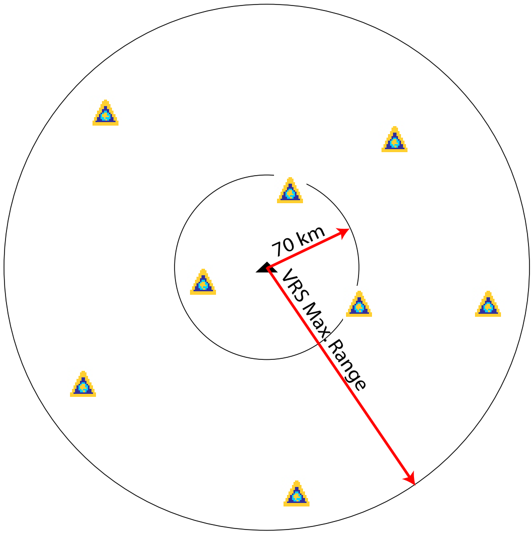
The VRS raw data file is derived from sets of raw data files collected simultaneously by different reference stations present around the working area. A minimum of three stations is required to run a VRS computation. There is no limit to the number of usable stations and you may freely reject those you do not want to use.

Stations should not be further than 70 kilometers (44 miles) from the chosen location, but by default, GNSS Solutions will pre-select the closest three stations, irrespective of whether they meet this requirement.

But if the number of available stations is insufficient, you will have to select more stations. For this reason, GNSS Solutions will also list (-but not pre-select) additional stations that comply with the **VRS Max. Range** criterion (default setting: 200 km, See *Creating a New Project on page 35*). It will therefore be your responsibility to select one or more of these stations to make the VRS processing executable.

The process of creating a VRS raw data file always includes the creation of a control point associated with this file. This point represents the location of the virtual reference station.

By default, the VRS raw data file will be generated to cover the total duration of all the observations present in the project if you selected a control point at the beginning of the process, or for the duration of the observation if you selected an observation file.



With a "virtual station" located on the survey site, you could instinctively deduce that the resulting baseline is always short, not to say "zero" in the case of static surveys and so the occupation times may be reduced accordingly. Unfortunately this is a wrong statement.

In the VRS processing, the baseline length is in fact tied to the geometry of the station network used. That is why the term "Equivalent Baseline Length" is used in this case, rather than "Baseline Length". The equivalent baseline length is usually slightly less than the baseline length to the closest reference station you involve in the process.

To assess the occupation times required in your post-processing survey, you should know the value of equivalent baseline length *before going to the field*. This can be done using GNSS Solutions, which will take into account the location of the working area and the number of usable stations as well as their geometrical configuration. With this parameter value in mind, you will be able to determine when enough data has been collected in your survey.

Reading Equivalent Baseline Length Before Going to the Field

If you intend to use the VRS function during the post-processing phase of your survey, it is essential that you be aware of the equivalent baseline length before going to the field. By doing this, you will know when to stop collecting data by simply monitoring the right indicator on your surveying equipment.

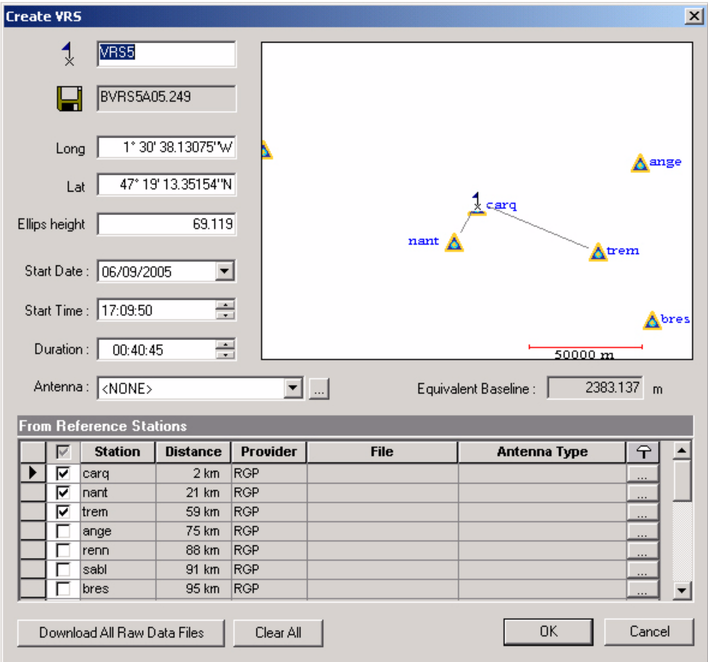
Follow the instructions below to read the equivalent baseline length for a given site:

- Create a GNSS Solutions project
- On the Survey view, create a control point located approximately at the center of your working area.
- Select the control point
- Select **Project>Compute VRS**. A window opens showing the network of usable stations in your working area. Note that the three closest stations have been pre-selected.
- Review the list of selected stations, looking at the distance that separates each of them from the control point, and modify the list if needed by clearing or checking on the corresponding button.
- When you agree with the list, read the value of the equivalent baseline length located just underneath the station network diagram.
- Write down this value, which you will have to remember when performing your survey.

Generating a VRS Raw Data File

Back in the office with several observation files collected in the field, do the following to compute a VRS raw data file:

- Download the observation files to your project.
- Select one of the observation file icons on the Survey view.
- Select **Project>Compute VRS**. the Create VRS window looks like this:

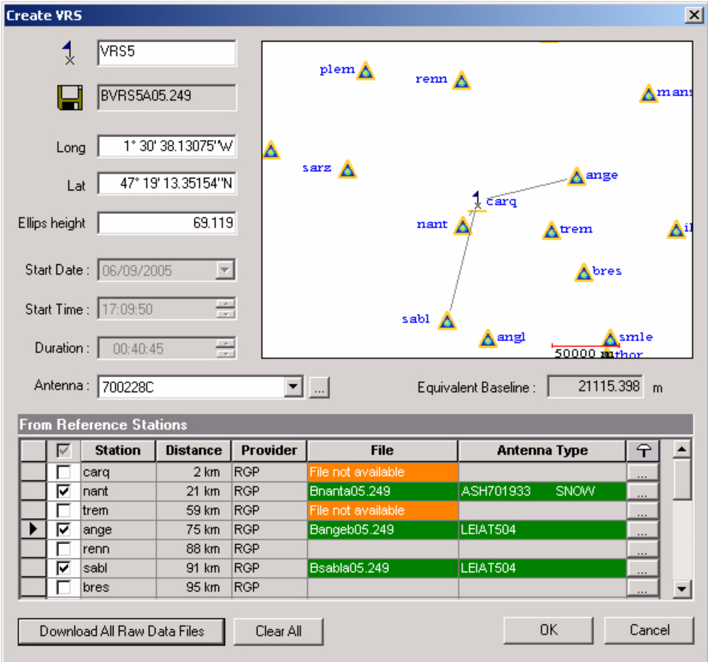


Field	Definition
	Name that will be given to the control point associated with the VRS raw data file once created (user-settable)
	Name that will be given to the VRS raw data file once created (software-set). NOTE: VRS raw data files use naming conventions similar to those of usual raw data files (B-files). The only difference is the presence, just after the letter “B”, of the term “VRS” followed by an index number, in lieu of the 4-character receiver ID.
East, North, Ellips Height	Autonomous GPS position solution attached to the observation file
Start Date	Date when observation file was created
Start Time	Time when observation started
Duration	Duration of observation
Antenna	Type of antenna used by the virtual station. <NONE> is the correct option for this parameter.
Equivalent Baseline	Gives the length of the equivalent baseline for the VRS raw data file, taking into account the current selection of reference stations.
“From Reference Stations” List	Lists all the reference stations around the location of the observation file. Only the closest three ones are preset. Other listed stations are within the distance criterion given by the **VRS Max. Range** parameter. For each station, the following information is provided: • Station name • Distance from selected observation file • Name of raw data provider
Download All Raw Data Files button	Once you have defined the list of reference stations, click this button to start downloading raw data from each of these stations. For each selected station, the following messages are returned as the downloading is in progress: Searching, downloading, uncompressing, merging, converting, importing, etc. The **File** and **Antenna type** columns are completed following import. A warning message will appear if the parameters of the detected antenna type are all “0”. In this case you will have to define these parameters by clicking in the cell to the far right.

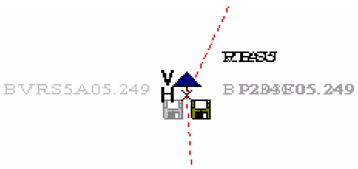
- Choose the closest reference stations (see table above).
- Click on the **Download All Raw Data Files** button (see table above) to gather all the raw data needed to compute a VRS raw data file.

VRS

Below is an example of what the VRS window might look like at the end of the download step:



- Click **OK** to start computing the VRS raw data file.
  At the end of this processing step, a greyed diskette icon appears on the Survey view, representing the VRS raw data file, as well as the associated control point.



Note that during this step, a "VRS.." folder was created in the project folder to save all the data files from the different stations involved in the VRS computation.

Processing Field Data with a VRS Raw Data File

After the VRS raw data has been created, GNSS Solutions automatically updates the processing scenarios, adding the new baseline(s) resulting from the new observation file and control point.

- Select **Project>Process Options**.
- In the Process Options window, read the new baseline(s) resulting from the new observation file and control point.
- Highlight a new baseline you would like to process by clicking in the corresponding cell on the far left. For example, select the baseline that connects the VRS raw data file to the observation file for which it was generated.
- Click **OK>To Save and Process selected Baselines**. GNSS Solutions computes the vector.
- Go to the workbook and read the results of the processing.

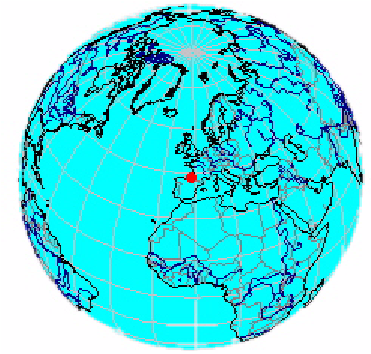
  In the Vectors tab, you will see the components of the computed vector. In our example, the computed baseline length should be about a few meters, reflecting the uncertainty on all positions computed in autonomous GPS mode.

  In the Points tabs, you will see the accurate coordinates of the point attached to your observation file.

Appendix A: Mission Planning Utility

Introduction

Mission Planning allows you to know which GPS satellites should be visible from a given observation point on the surface of the Earth, and for a given period of time (max. 24 hours). The World Map editor (see below) allows you to quickly define an observation point.



Mission Planning uses almanac data sent by GPS satellites to perform a prediction. Each set of almanac data provides the orbital parameters for the whole GPS constellation. Almanacs are assumed to be valid for a period of time centered around a reference time called TOA (Time Of Almanac). The closer to the time of prediction the TOA of the chosen almanacs, the more reliable the prediction.

Mission Planning allows you to import new sets of almanac data saved in Spectra Precision proprietary formats (SFIX, SVAR or SBIN), or of the following type: SEM<Week No.>.TXT (almanac files downloaded from the US coastguards site: www.navcen.uscg.gov).

Mission Planning can also display the set of almanacs used (see below).

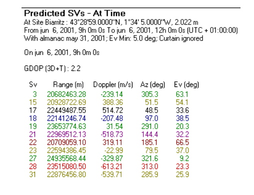
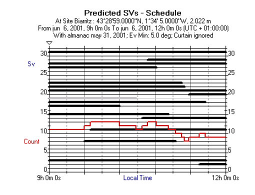
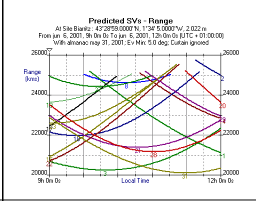
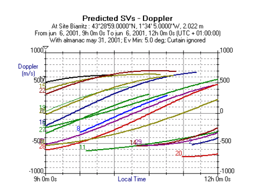
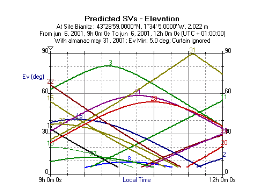
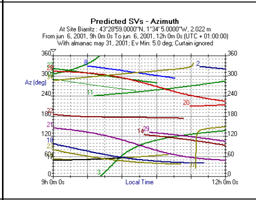
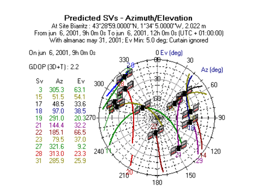
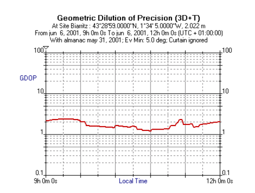
Prediction - Almanac (1 / 29)

Thursday, May 31, 2001 - 16:38:24

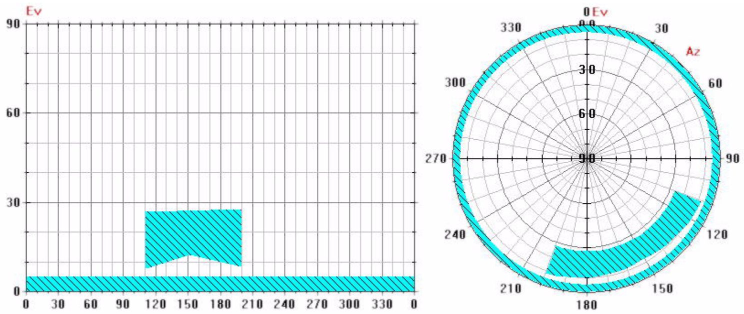
SV PRN :	1
Health :	0
Eccentricity :	0.51250458E-2
Time of Applicability (s) :	405504
Orbital Inclination :	55°16' 5.6433"
Rate of Right Ascen (deg/s) :	-4.6428E-7
Semi-Major Axis (m) :	26558562.250
Right Ascen at TOA :	212°34' 6.6688"
Argument of Perigee :	262°48'59.5054"
Mean Anom :	184°48'31.8868"
SV Clock Bias - Af0 (µs) :	180.2444
SV Clock Drift - Af1 (ns) :	0.0000
Week :	1116

Page Up   Page Down

Mission Planning produces the following views to help you analyze the results of the prediction:

At Time	Schedule	Range
		
Doppler	**Elevation**	**Azimuth**
		
Polar	**GDOP**	
		

Mission Planning also allows you to edit curtains and to apply them to the observation point (see below and *Curtain editor on page 267*). A curtain is a pattern representative of the obstructions around the observation point and liable to disturb the reception of GPS signals at this point.



Almanacs used in the prediction

❑ Opening a set of almanacs

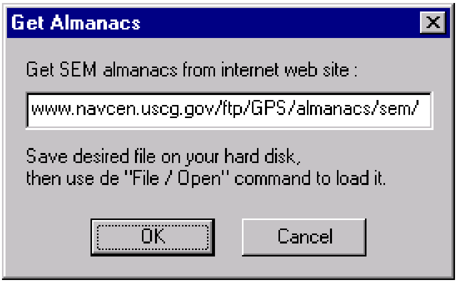
When launching **Mission Planning**, the set of almanacs last loaded is used. To open a new set of almanacs:

- Click on , or in the menu bar, select **File>Open**. A dialog box opens showing the list of some of the almanac files stored in the **Raw** directory.
- In the lower part of this box, specify the format of the almanac file you would like to open. The possible choices are:
  - ASCII (*.raw)
  - Binary (*.bin or *.dXX)
  - Ashtech almanac files (a*.*)
  - SEM almanacs from the US coast gards (Sem*.txt)
- Choose the desired set of almanacs from the files list, then click **Open** to load it.

❑ Importing a new set of SEM-type almanacs

Using this function requires that your PC can be connected to the Internet.

- In the menu bar, select **Help>Get Almanacs**. A new dialog box opens asking you to confirm the address of the US coast guards site (currently www.navcen.uscg.gov) with direct access to the almanac page /ftp/GPS/almanacs/ sem/



- Click **OK** to launch your Internet browser, which then automatically connects to the requested site
- Choose the desired set of almanacs from the list and then display it on the screen
- Save this set of almanacs as a TXT file in your local **Raw** directory then leave the site.

To use this new set of almanacs, open it in **Mission Planning** as explained previously.

❑ Viewing the set of almanacs used

- On the menu bar, select **View>Almanac**. The main window then shows the set of almanacs currently used in the form of numerical data. Click on **Page Up** or **Page Down**, or on the corresponding keys on the keyboard, to view the almanac for the next or previous satellite (each screen provides the orbital parameters for a single satellite).

  Example of almanac for satellite No.1 at the specified date and time:

  Prediction - Almanac (1 / 29)

  Thursday, May 31, 2001 - 16:38:24

SV PRN :	1
Health :	0
Eccentricity :	0.51250458E-2
Time of Applicability (s) :	405504
Orbital Inclination :	55°16' 5.6433''
Rate of Right Ascen (deg/s) :	-4.6428E-7
Semi-Major Axis (m) :	26558562.250
Right Ascen at TOA :	212°34' 6.6688''
Argument of Perigee :	262°48'59.5054''
Mean Anom :	184°48'31.8868''
SV Clock Bias - Af0 (µs) :	180.2444
SV Clock Drift - Af1 (ns) :	0.0000
Week :	1116

  Page Up   Page Down

Defining the observation point

When launching **Mission Planning**, a prediction for the last selected observation point is run.

You can preset the observation point from the GNSS Solutions window by doing the following:

- Select the desired observation point in any of the open documents (table, map, etc.)

- Press **F2**. This automatically launches Mission Planning. The selected point in GNSS Solutions then becomes the observation point in Mission Planning.

The parameters defining an observation point are its name, its WGS84 coordinates (Lat/Lon/Alt), and the curtain placed on this point.

The definition of an observation point can be saved to be used at a later date.

To define the observation point:

- Click on , or on the menu bar, select **Edit>Site** and complete the following fields:

  Site: Give a name to the observation point

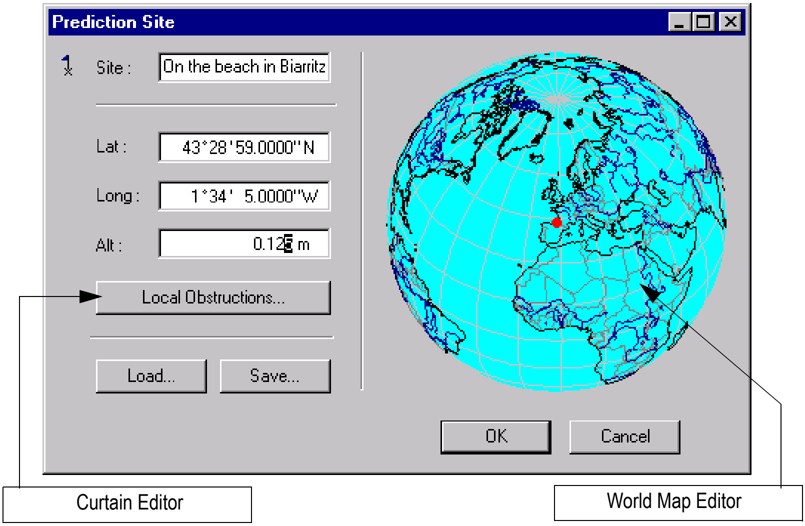
  Lat, Long: Enter its latitude and longitude:
  - By completing manually the **Lat** and **Long** fields
  - Or by using the World Map Editor located on the right. This tool allows you to complete automatically the previous two fields by selecting the point graphically on the surface of the globe (see *World Map editor on page 264*)
- **Alt**: Define the point’s altitude by completing manually this field

Local Obstructions button: This button provides access to the Curtain Editor, which you can use if you wish to define a curtain around the observation point. A default curtain exists which consists of all the space between 0° elevation and the minimum elevation angle above which satellites are used. See *Curtain editor on page 267*.

Load... button: Allows you to select an observation point saved earlier as a Pos file in order to use it as the current observation point

Save... button: Allows you to save the current observation point as a *.Pos file (stored in **Pos** directory) for further use.

Dialog box allowing you to define an observation point:



Use of Curtain Editor: see *Curtain editor on page 267*

Use of World Map Editor: see *World Map editor on page 264*

Defining the date & time of prediction

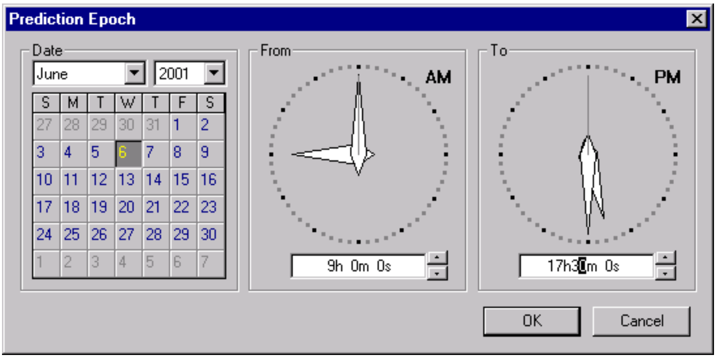
When launching **Mission Planning**, a prediction for the current date & time is automatically computed.

The parameters defining a time of prediction are the date (month, year, day) and the start & end times (max. observation time span: 24 hours).

To define a new date & time of prediction:

- Click on , or on the menu bar, select **Edit>Epoch** and select the following in the dialog box that opens:
  Date: Select month, year and date of prediction
  From: Enter start time of prediction
  To: Enter end time
- Click **OK** to complete the definition.

Dialog box allowing you to define the date & time of prediction:

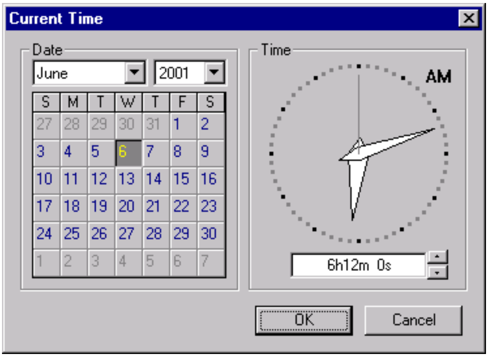


Defining a moment within the prediction

You can define a particular moment within the prediction time span:

- Click on  or on the menu bar, select **Edit>Cur. Time**
- In the lower-right corner, specify the interesting moment (in hours, minutes, seconds)
- Click **OK** to complete the definition.

Dialog box allowing you to define a particular moment within the prediction:



This particular moment in the prediction can be shifted graphically on any prediction view. *See Redefining a specific moment in the prediction on page 260.*

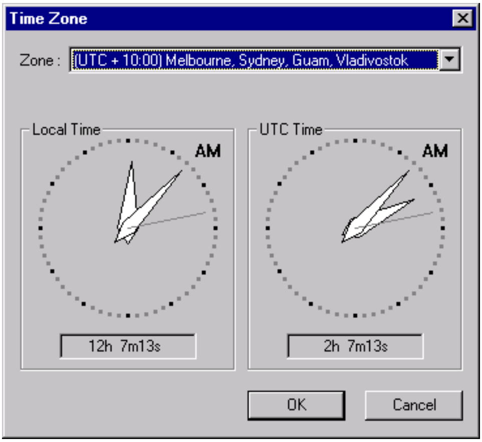
Defining the local/ UTC time deviation

This deviation identifies the time zone in which the observation point is located.

To change this deviation:

- On the menu bar, select **Edit>Time Zone**
- Select the working area in the **Zone** field
  You can also enter a deviation expressed in hours, minutes and seconds by selecting the “UTC+HH:MM:SS” option in the **Zone** field, and then by entering the value of time deviation in the **HH:MM:SS** field shown just below
- Click **OK** to complete the definition.

Dialog box allowing you to define the local/UTC time deviation:



Prediction results

Prediction results are provided in the form of graphs called “views”. Apart from the **At Time** and **Polar** views, all the views use an axis system with the prediction time span represented along the X axis (a linear scale is used and each graduation represents 1/10th of the total prediction time span). Along the Y axis are represented the possible values of the displayed parameter which may be one of the following:

- On **Schedule** View: SV No. (1 to 32) **AND** No. of visible satellites
- On **Range** View: distance from 20 000 to 26 000 km
- On **Doppler** View: Doppler from -1000 to +1000 m/s
- On **Elevation** View: Elevation angle from 0 to 90°
- On **Azimuth** View: azimuth angle from 0 to 360°
- On **DOP** View: DOP from 0.1 to 100 (logarithmic scale)

The **Polar** view uses polar coordinates as suggested by its name. The **At Time** view provides numerical data for one given moment chosen in the prediction.

To select a view:

- Select **View>[View Name]** or, after placing the mouse cursor anywhere within the display zone, choose it from the menu displayed after a right click on the mouse.

The following information is provided in each view subtitle:

- Label & XYZ coordinates of the observation point (1st line)
- Prediction start & end times (2nd line)
- Validity date of the almanac data used in the prediction, minimum elevation angle and presence or absence of a curtain (3rd line).

❑ "At Time" view

The "At Time" view lists the positions of the visible satellites from the observation point, for the moment chosen in the prediction.

Example of "At Time" view:

Predicted SVs - At Time

At Site Biarritz : 43°28'59.0000"N, 1°34' 5.0000"W, 2.022 m
From jun 6, 2001, 9h 0m 0s To jun 6, 2001, 12h 0m 0s (UTC + 01:00:00)
With almanac may 31, 2001; Ev Min: 5.0 deg; Curtain ignored

On jun 6, 2001, 9h 0m 0s

GDOP (3D+T) : 2.2

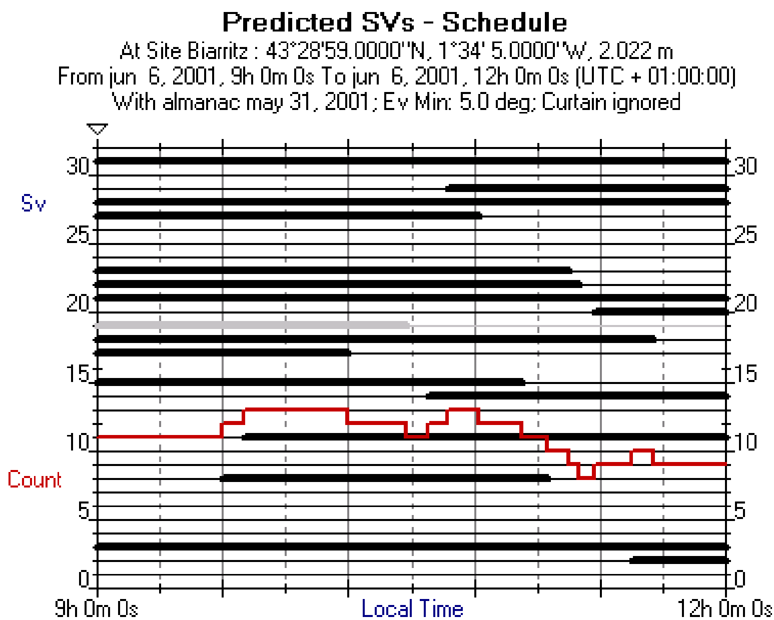
Sv	Range (m)	Doppler (m/s)	Az (deg)	Ev (deg)
3	20682463.28	-239.14	305.3	63.1
15	20928722.69	388.36	51.5	54.1
17	22449487.55	514.72	48.5	33.6
18	22141246.74	-207.48	97.0	38.5
19	23653774.63	31.54	291.0	20.3
21	22969512.13	-518.73	144.4	32.2
22	20709059.10	319.11	185.1	66.5
23	22594386.45	-22.99	79.5	37.0
27	24935568.44	-329.87	321.6	9.2
28	23515080.50	-613.21	313.0	23.3
31	22876456.80	-539.71	285.9	25.9

❑ "Schedule" view

This view shows the times when each satellite is visible, as well as the total number of visible satellites at any given time within the prediction.

The period of time during which a satellite is visible is represented as a bold horizontal line. The red multi-line is representative of the total number of visible satellites at any time during the prediction. Grey lines, if any, indicate unhealthy satellites.

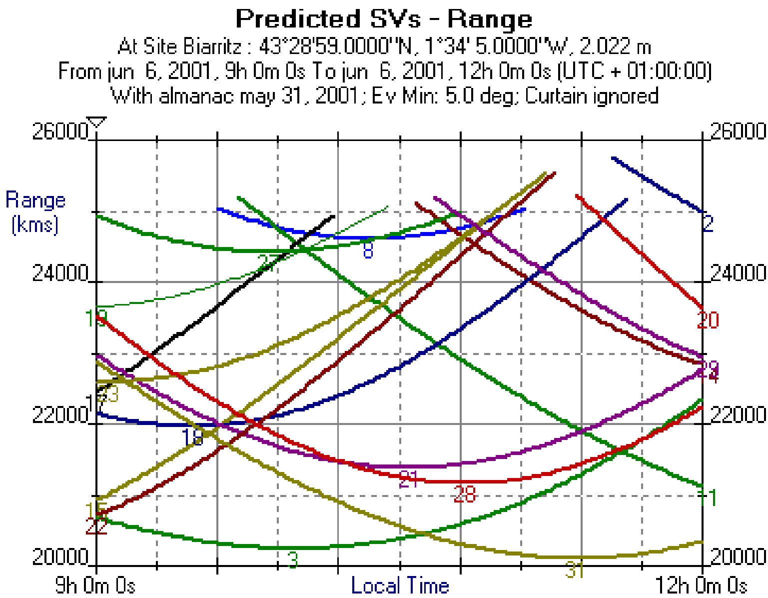
Example of "Schedule" view:



❑ "Range" view

This view shows the variations of distance between each of the visible satellites and the observation point.

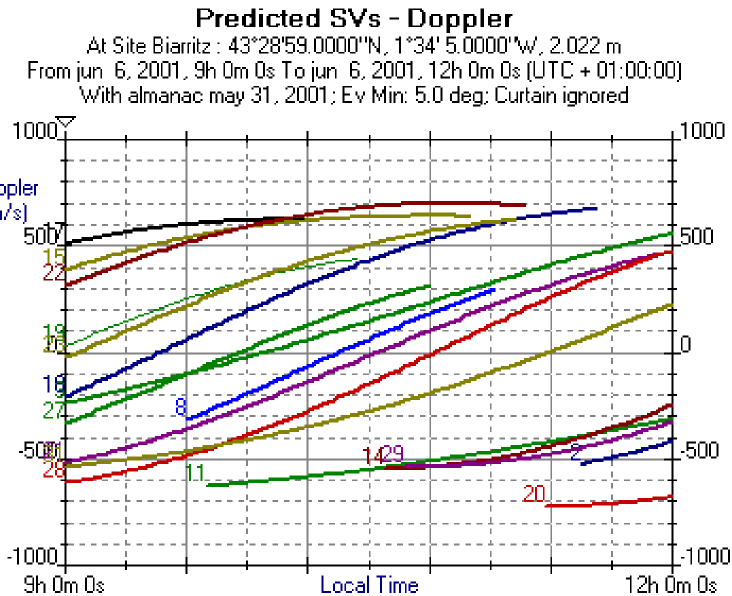
Example of "Range" view:



❑ "Doppler" view

This view shows the variations of speed for each of the visible satellites with respect to the observation point.

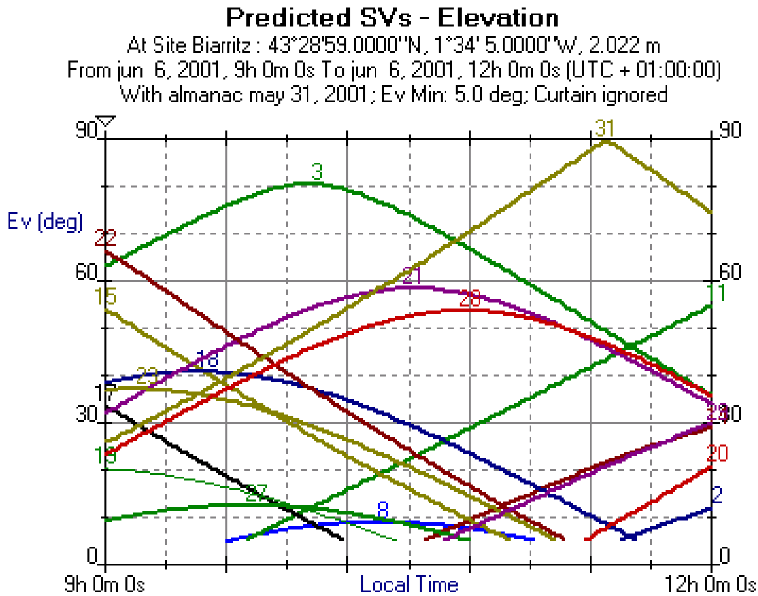
Example of "Doppler" view:



❑ "Elevation" view

This view shows the variations of elevation for each of the visible satellites during the prediction.

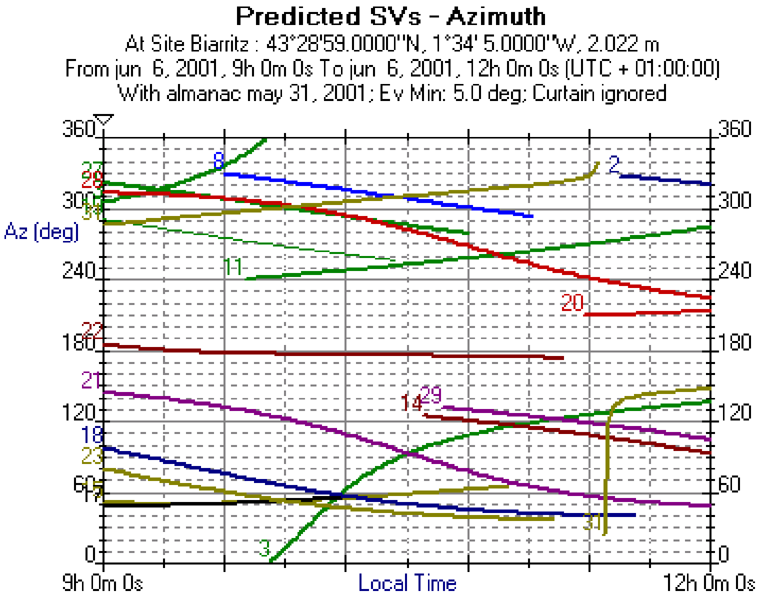
Example of "Elevation" view:



❑ "Azimuth" view

This view shows the variations of azimuth for each of the visible satellites during the prediction.

Example of "Azimuth" view:

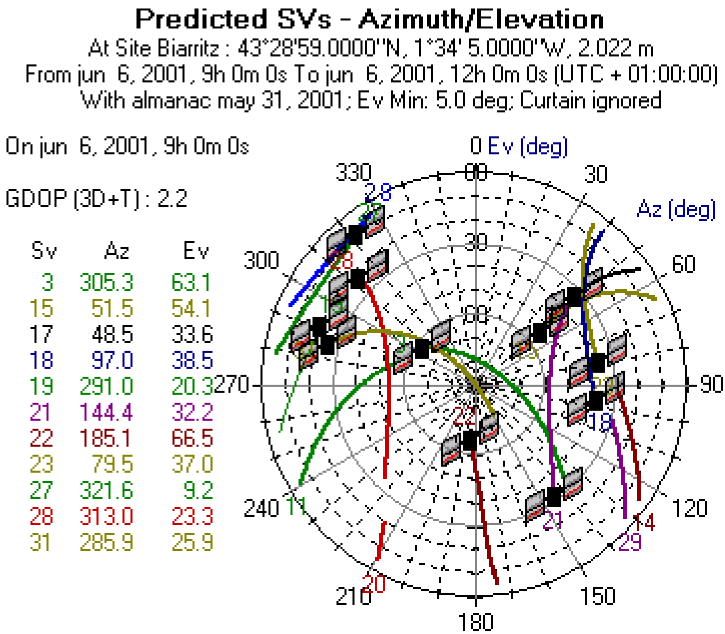


❑ "Polar" view

This view shows the orbit of each of the visible satellites above the observation point, for the whole prediction time, as well as the planned position of each of these satellites for the chosen moment. The view uses polar coordinates:

- Center of concentric circles: location of observation point
- From center to larger circle: elevation angle, from 90° to 0° respectively (each new circle represents 10° in elevation)
- The angular space between any two adjacent lines represents 30° in azimuth; graduated clockwise from 0 to 360°.

Example of "Polar" view [Azimuth=f(elevation)]:



❑ "GDOP" view

This view shows the variations of the selected DOP as a function of the fix computation envisaged on the observation point:

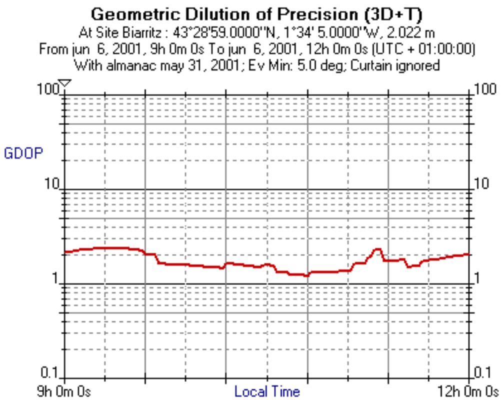
To select which DOP parameter to plot:

- Select **Options>DOP... >[Parameter Name]** The possible choices are:
  - GDOP: Geometric Dilution Of Precision
  - PDOP: Position Dilution Of Precision
  - HDOP: Horizontal Dilution Of Precision
  - VDOP: Vertical Dilution Of Precision
  - TDOP: Time Dilution Of Precision

Define the type of fix computation envisaged at the observation point so that **Mission Planning** can determine the corresponding DOP values:

- Select **Options>3D+T** or **Options>2D+T**
  2D+T should be chosen if the altitude is known and constant throughout the working area around the observation point, otherwise choose 3D+T. In 2D+T only 2 position unknowns, instead of 3, are involved in the GDOP computation. This naturally results in better (lower) GDOP figures.

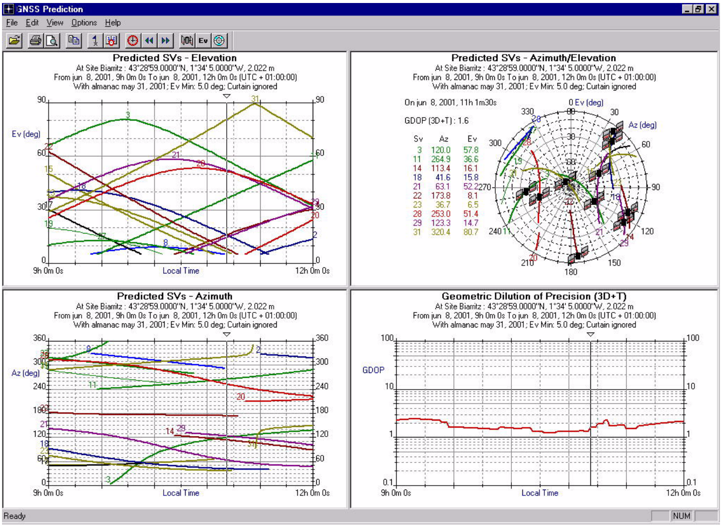
  Example of "GDOP" view:



❑ Displaying 4 or 2 different views at the same time

- Select **View>Split** and then click in the middle of the window with the left-mouse button. The window is split into 4 areas, each of them showing a different view of the prediction.

  Example of a screen showing 4 different views at the same time:



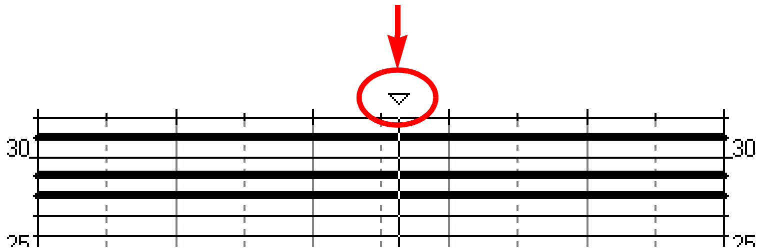
- To choose a different view in an area, position the mouse cursor anywhere within the area and then select the desired view from the menu displayed after a right click
- Switching to two views and then back to a single view are simply obtained by dragging the concerned border out of the window or by double-clicking on it.

❑ Copying or printing the active view

- Click on or select **Edit>Copy** to copy the active view to the clipboard so you can paste it in a document created with another program. In the case of several views displayed concurrently, the active view is merely the one in which you have last clicked.
- Click on or select **File>Print Preview** to preview the active view
- Click on or select **File>Print** to print the active view.

❑ Redefining a specific moment in the prediction

For all views on which the X axis represents the total duration of prediction, the specific moment (see *Defining a moment within the prediction on page 248*) is denoted by a marker (a down-arrow):



This marker may be shifted towards the beginning or the end of the prediction using one of the following methods. Whatever the method you use, the **Current Time** dialog bow will always be updated following this operation.

1. By directly clicking inside the graph where you would like the marker to be located

2. Using the following buttons on the toolbar:
   - Click on  to move the marker one step forward
     or
   - Click on  to move the marker one step backward.
3. Using the following buttons on the keyboard:
   - A short press on the "+" key (numeric keypad) will move the marker one step forward. A long press will cause the marker to move forward until you release the key.
   - A short press on the "-" key (numeric keypad) will move the marker one step backward. A long press will cause the marker to move backward until you release the key.

The specific moment in the prediction can also be changed on the **At Time** or **Polar** views using the 2nd or 3rd method described above.

Changing the prediction options

❑ Deselecting satellites

- Click on  or, on the menu bar, select **Options>Svs...** A dialog box opens allowing you to modify the set of satellites involved in the prediction.
  The first time you display this box for any given prediction, all visible satellites have been selected to be used in the prediction. Satellite numbers (PRN) shown in black letters stand for the visible satellites whereas those in white stand for the non-visible ones. All buttons are in the "OFF" position (i.e. released). The changes you can make are the following:
  - Deselecting a satellite: depress the corresponding button

- Deselecting all satellites: click on the **All** button
- Re-selecting a satellite (that you have previously deselected): click on the corresponding button (which then comes back to the “OFF” position)
- Re-selecting the complete set of visible satellites: click on the **None** button.

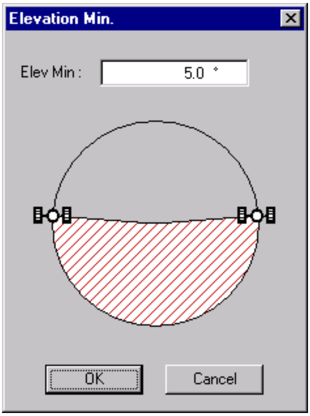
Example of settings on the SVs Deselection box:

In this example, satellites No. 12, 16 and 32 are not visible, satellite No. 22 is visible but deselected, satellite No. 32 is not visible and furthermore is deselected. All other satellites are visible and used.

❑ Changing the minimum elevation

- Click on or, on the menu bar, select **Options>Elev Min...** A dialog box opens allowing you to change the value of the minimum elevation angle under which any satellite should be seen from the observation point for it to be used in the prediction.

Minimum Elevation dialog box:



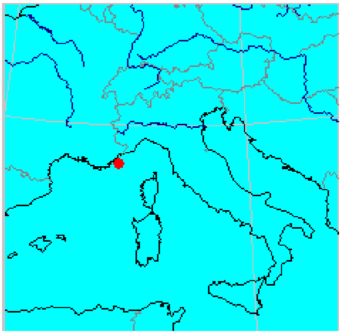
❑ Applying / removing the curtain

- Click on or, on the menu bar, select **Options>Use curtain**. A dialog box opens in which you can apply (button depressed) or remove (button released) the curtain defined on the observation point.
  The curtain, which is part of the observation point definition (see *Defining the observation point on page 244*), describes an angular area seen from the point. All GPS signals received from that area will NOT be used.
  The presence of the curtain (size and shape shown on the **Polar** view, impacts most of the other views in the prediction.

World Map editor

The World Map editor shows the planet Earth. From this view, you can select any point on the surface of the Earth where you would like to run a prediction. The World Map editor is equipped with a number of functions allowing you to access this point.

Example of a view obtained with the World Map editor:



❑ Rotating the Earth

If the visible part of the World Map editor does not show the desired observation point, do the following:

- Position the mouse cursor anywhere on the globe
- Right-click on the mouse and select **Grabber**.

  The mouse pointer now looks like this: 
- Hold down the mouse left button and drag in the direction that would bring the desired point on the visible part of the globe. When you release the mouse button, this will cause the globe to rotate around its axis by an angle proportional to the distance traveled by the mouse pointer while dragging.

❑ Zooming in

- Position the mouse pointer anywhere on the globe
- Right-click on the mouse and choose Zoom in.

  The mouse pointer now looks like this:
- Position the mouse pointer on the globe where you would like to zoom in, and then click on the left button. This causes the region to be magnified. The center point of the magnified view is in fact the point where you have just clicked

  You can repeat this operation several times (as long as the mouse pointer is a “+” magnifying glass). From the initial view showing all the globe, up to 6 successive zoom-in operations can be performed.

❑ Zooming out

- Position the mouse pointer anywhere on the globe
- Right-click on the mouse and choose **Zoom out**.

  The mouse pointer now looks like this:
- Position the mouse pointer on the globe where you would like to zoom out, and then click on the left button. This causes the region to be reduced in size. The center point of the reduced view is in fact the point where you have just clicked.

  You can repeat this operation several times until the entire globe can be seen on the screen.

❑ Selecting a point

Once the globe is large enough to make a visual estimate of the desired observation point on the globe’s surface, do the following:

- Position the mouse pointer anywhere on the globe
- Right-click on the mouse and choose **Draw**.

  The mouse pointer now looks like this: +
- Position the mouse pointer very accurately on the desired point, then click on the left mouse button to define this point.

The **Lat** & **Long** fields in the dialog box are then updated to reflect the exact coordinates of the point you have just selected. Note that the **Alt** field is left unchanged. This parameter should be defined manually by typing its value directly in the field.
On the globe, the selected point is shown as a red dot whose size is independent of the zoom setting.

❑ Globe Viewing Options

- Position the mouse pointer anywhere on the globe
- Right-click on the mouse and choose **Options**. A dialog box opens in which you can change the globe viewing options. The defaults for these options are the following:

The available 4 resolutions are:
- low
- medium
- high
- very high

The higher the resolution, the more accurate the details on the globe surface.

Curtain editor

❑ What is a curtain?

Seen from the observation point, some directions in space may exist in which GPS reception for some reason is bad. The concept of *curtain* is introduced specifically to describe these particular directions so that the signals received from this region of space can be curtained if necessary.

For a given observation point, the curtain consists of one or more *obstruction zones* seen from this point. Each obstruction zone is defined in relation to Azimuth (Az) and Elevation (Ev).

A curtain may be drawn on a polar view centered on the observation point, or on linear view showing elevation vs. azimuth. Once the curtain is drawn on a view, it is also visible on the other.

A curtain may also be defined by specifying each of the points making it up. As a result, the curtain also appears on the two views as if it had been drawn.

On the chart, the area located between Elevation Angle 0° and the user-set **Min Elev** angle (see bottom of the tab) is considered as part of the curtain (also shown in blue).

When you enable the curtain in a prediction computation, you allow the application to behave as if there were no GPS signals received in the curtain's direction.

❑ Accessing the curtain editor for a given observation point

- Click on , or in the menu bar, select **Edit>Site**
- Define the observation point, or load it if it has already been defined and saved
- Click on the **Local Obstructions...** button.

❑ Changing the curtain view

- Position the mouse pointer anywhere on the curtain editor
- Right-click on the mouse and select the linear or polar view.

❑ Drawing a curtain

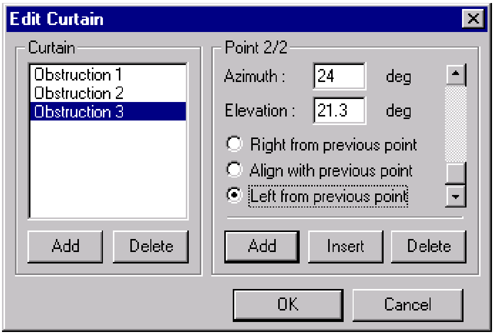
- Position the mouse pointer anywhere on the chart and click with the right mouse button
- In the shortcut menu that pops up, select the **Draw** command.

  The mouse pointer then changes to +
- Position the mouse pointer on the desired location, referring to the Az and Ev indications, and click with the mouse to begin drawing the curtain.
- Move the mouse pointer to reach the next point. Note the curve that results from the pointer displacement (a straight line on the **Linear** view, an arc on the **Polar** view). Once you have reached the next point, click with the mouse again, etc.
- If you need to go through the 0/360° or 360/0° limits while you draw an obstruction zone, move the pointer outside the chart. This causes the horizontal scale to move accordingly so long as you keep the pointer outside the chart.
- To complete the curtain definition, double-click on the last point. As a result, the curtain appears in blue as a closed shape, even if the last point is not superimposed on the first one. On the **Linear** view, the curtain is always a polygon, on the **Polar** view it is a close shape composed of several arcs.
- After completing the definition of the obstruction zone and if you want to restore a 0/360° normal non-shifted scale (if appropriate), choose the **Select** command from the pop-up menu and then simply double-click inside the chart area with the left-hand mouse button.

❑ Editing a curtain manually

After accessing the curtain editor chart:

- Position the mouse pointer anywhere on the graph and click with the right mouse button.
- In the shortcut menu that pops up, select the **Edit Curtain** command.
- In the dialog box that appears, specify the points delimiting the obstruction zone(s).



Curtain pane:

- List box: Shows the number of obstruction zones defined to form the curtain for the concerned site. Obstruction zones are numbered from 1 to n. The definition of the selected obstruction is shown in the right-hand part of the box
- **Add** button: Press this button to add a new obstruction zone in the above list box
- **Delete** button: Press this button to delete the obstruction zone selected in the above list box.

Point {x/x} pane:

- **Azimuth**: Azimuth angle for the displayed point
- **Elevation**: Elevation angle for the displayed point
- **Right from previous point:** Check this button if you want the position you are defining to be somewhere on the right of the previous point (this choice will force the extension of the obstruction zone to the right of the previous point even if the azimuth angle of the new point is less than that of the previous one; this allows you to go through the 360/0° singular value).
- **Align with previous point**: Check this button if you want the position you are defining to be aligned with the previous point (i.e. same azimuth)
- **Left from previous point**: Check this button if you want the position you are defining to be somewhere on the left of the previous point (this choice will force the extension of the obstruction zone to the left of the previous point even if the azimuth angle of the new point is greater than that of the previous one; this allows you to go through the 0/360° singular value)
- **Add** button: Click this button to add a point to the definition of the obstruction zone. As a result, the total number of points (see top of dialog box) is incremented by one
- **Insert** button: Click this button to add a point to the definition of the obstruction zone. The new point is inserted into the list of points **just before** the displayed point. As a result, the total number of points (see top of dialog box) is incremented by one
- **Delete** button: Click this button to delete the point displayed above
- **OK** button: Click this button to validate the entire box content
- **Cancel** button: Click this button to cancel all the changes you have made to the box since you opened it.

❑ Moving, re-shaping or deleting a curtain

- Position the mouse pointer anywhere on the graph and click with the right mouse button
- In the shortcut menu that pops up, choose the **Select** command
- Select the curtain by clicking the mouse pointer inside the drawing object (a selected curtain displays handles) then:
  - Drag this object to move the curtain
  - Or drag each of its handles successively to re-shape it
  - Or press the **Del** key to delete it. ❑

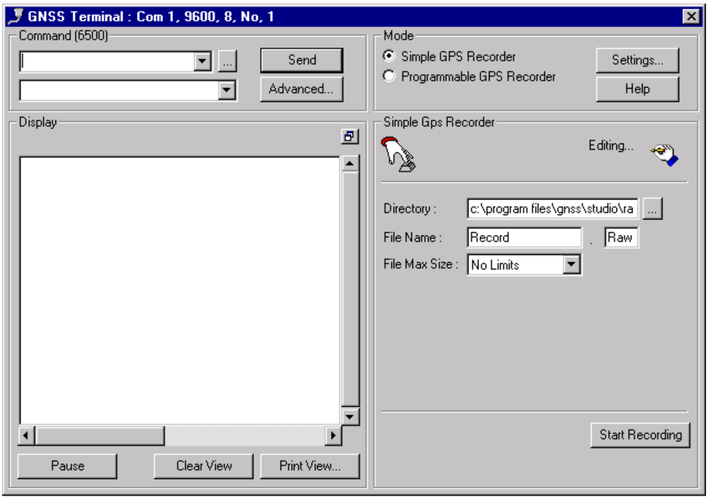
Appendix B: WinComm Utility

Introduction

WinComm allows you to communicate with GPS receivers by offering the following functions:

- Automatic search for baud rate to be used (on operator's request, only with Spectra Precision receivers)
- Identification of the connected GPS receiver (on operator's request, only with Spectra Precision receivers)
- Viewing the data stream on the serial port
- Sending commands to the GPS receiver
- Manual request for recording data from the GPS receiver
- Programmable requests for recording data from the GPS receiver.

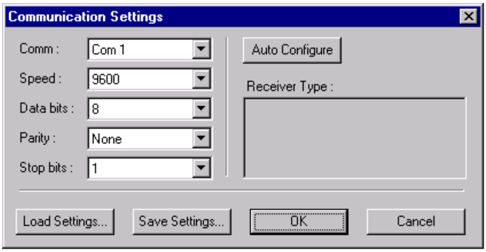
WinComm main window:



Enabling communications with a GPS receiver

After you start **WinComm** or click the **Settings** button in the **WinComm** main window, the **Communication Settings** dialog box shows up. This dialog box allows you to view and change the serial port parameters of your computer and enable communications with the GPS receiver connected to it.

Communication Settings Dialog Box:



You can save your customary communications settings to a configuration file (using the **Save Settings** button) and specify the configuration file name in the command line of any shortcut created to start **WinComm**. As a result the configuration file will automatically be loaded and enabled when you double-click the **WinComm** icon to start **WinComm** (in that case the **Communication Settings** dialog box will not be prompted).

Use the combo boxes to set the communication parameters. The parameters are preset to default values. Select the desired port (**Comm** parameter), that is the computer port connected to the desired GPS receiver and the appropriate serial communication parameters (baud rate, etc.) to match those of the receiver.

With Spectra Precision receivers, the baud rate will be adjusted automatically if you use the **Auto Configure** button.

❑ OK button

Clicking the **OK** button activates the current serial port parameter settings and closes the **Communication Settings** dialog box. This enables communications between the computer and the GPS receiver, unless the serial port parameter settings do not match those of the receiver connected.

❑ Cancel button

Clicking the **Cancel** button closes the **Communication Settings** dialog box. Any changes you made in this dialog box are ignored.

❑ Auto Configure button

Auto Configure initiates an automatic search for the baud rate and receiver type. Use this button if you are not sure about the baud rate or if you wish to view the type of the receiver connected.

An automatic search for the baud rate and receiver type is only allowed with Spectra Precision receivers as this requires that the receiver be capable of returninng a consistent reply to a "TEST 1" or "IDENT" command.

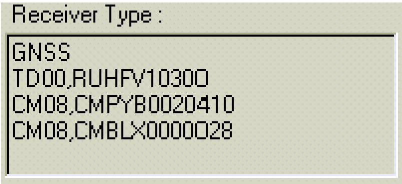
After choosing **Auto Configure** you are allowed to:

- Disable the communication by clicking **Cancel**
- Or, if the identification is successful, close the **Communication Setting** dialog box, by clicking **OK**. This enables communications between the computer and the GPS receiver and allows you to use any of the **WinComm** functions.

❑ Receiver Type

After communication is successfully established (e. g. using the **Auto Configure** button), the identification of the connected receiver appears in this box.

The example below results from a communication established with a Spectra Precision receiver.



After the **Communication Settings** dialog box is closed, you can ask for the receiver type by sending the TEST 1 or IDENT command to the connected receiver, using the **Command** pane.

❑ Load settings button

Load settings opens a dialog box that allows you to select any serial port configuration file saved earlier using the **Save Settings** button.

Click the desired file name in the list box, to select it (typically in the 'set' directory), and click **Open**. As a result the serial port parameters in the **Communication Settings** dialog box are automatically set as specified in the file you selected.

(Clicking **Cancel** would take you back to the **Communication Settings** dialog box).

❑ Save settings button

Save settings opens a dialog box that allows you to save the serial port configuration currently enabled so that you can quickly retrieve it at a later date using the **Load Settings** button. It can be loaded automatically if you specify its name in the command line of any shortcut icon created to start **Wincomm**.

In the **File Name** text box, enter a name (e.g. the type of the receiver connected) for the file to which the serial port configuration should be saved (typically with '.set' as the extension name and saved to the 'set' directory).

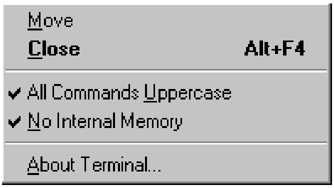
Clicking the **Save** button saves the following communication parameters:

- Serial port No.
- Baud rate
- Number of bits per character
- Parity check option
- Number of stop bits

(Clicking **Cancel** would take you back to the **Communication Settings** dialog box without saving any settings).

System Menu

- In the left corner of the **WinComm** window's title bar, click on the connector icon. The system menu appears from which you can define the options below.



- **All Commands Uppercase**: Unless you are satisfied with the current setting, select this command to toggle the setting.
  Checked: lower-case characters in the command are changed to upper-case characters before being sent to the receiver
  Cleared: characters, whether lower-case or upper-case, are sent unchanged.

- **No Internal Memory**: Command not used with the new range of receivers. Unless you are satisfied with the current setting, select this command to toggle the setting.
  Checked: there is no internal memory in the attached receiver (**Internal Memory Reader** option disappears from the **Win Comm** window). Always make this choice with the current range of receivers.
  Cleared: there is an internal memory in the attached receiver (**Internal Memory Reader** option available in the **Win Comm** window).

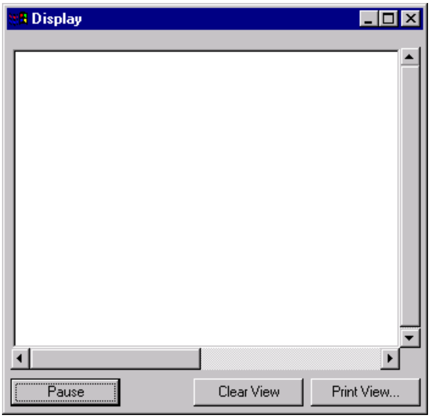
Display area

After communication is enabled between the computer and a GPS receiver the **Display** pane allows you to view the data stream on the receiver port, including data output in response to any command generated by **Wincomm**.

If you wish to enlarge the **Display** pane, click in this pane (top right). This causes the pane to be transformed into a separate window which you can move/ re-size using the usual commands assigned to windows in the *Windows* environment.

To restore the **Display** pane at the initial location, click or (top right).

Display area defined as a separate window:



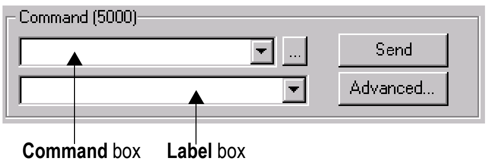
As the data may be refreshed every 0.1 seconds, it is not possible to log all that flows through the port so that it can be displayed at a later date, or this would require a huge memory size. For that reason, only the latest 100 data lines are stored and can be viewed using the vertical scroll bar available.

Each data line ends with <CR><LF> characters and/or when it reaches the maximum length (80 characters).

Clear View: Clicking this button deletes any data displayed in the **Display** pane / window.
Print View: Clicking this button opens a **Print** dialog box that allows you to print any data displayed in the **Display** pane/window.
Pause: Freezes the **Display** pane/window and changes the label of the button to **Resume**.
Pressing the **Pause** button does not suspend the data flow on the receiver port or the recording in progress.
Pressing this button again (now changed to a **Resume** button) will re-activate the **Display** pane/window.

Sending a Command to the GPS receiver

After communication is established between the computer and the GPS receiver, the **Command** pane can be used to send commands to the receiver (label of selected command group recalled in the command pane, see example below).



To send a command, do the following:
- Type the command in the **Command** combo box or select it from the **Command** or **Label** combo box.
- Click the **Send** button.

The list of commands prompted in the **Label** combo box can be changed using the **Advanced...** button.

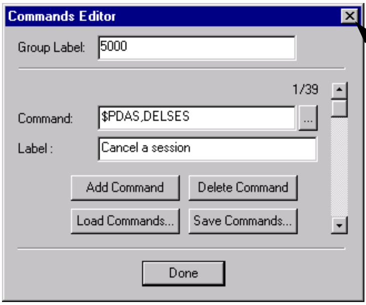
❑ Commands editor dialog box

This dialog box (appearing after you click the **Advanced** button) allows you to set up a group of commands interpretable by the connected receiver. The commands you select in this dialog box will be prompted in the main window. As a result, you will only need to choose the desired command from the list in the main window and click to send the command to the receiver.

After you install **WinComm**, a number of default command groups are available on your computer. Each command group is contained in a file whose name is the **Group Label** (see this parameter in the next page), with **.cmd** as extension.

The buttons in the **Commands Editor** dialog box allow you to load any command-group file available, make any change to the group and save your own command groups.

The selected command group will be available in the main window after you close the **Commands Editor** dialog box (by clicking in the upper-right corner).



Click here to close the **Commands Editor** dialog box. This loads the selected command group to the main window.

Group Label: Used to enter and/or view the name given to a command group. For example, this name can suggest the type of receiver connected when this command group should be used

WinComm

Command: Used to enter and/or view each command script. Use the associated scrollbar to browse through the list of available commands

Label: Used to enter and/or view a plain label for each command script. Use the associated scrollbar to browse through the list of available commands

Add command: Adds the command viewed in the text box to the list of available commands.

Delete command: Removes the command viewed in the text box from the list of available commands.

Load commands: Opens a dialog box that allows you to choose the appropriate command group file for the connected receiver. The command group becomes available in the main window after you close the **Commands Editor** dialog box.

Save commands: Opens a dialog box that allows you to save your own command group (as viewed in the **Commands Editor** dialog box).

Simple GPS recorder

All data output from the receiver's port is viewed in the main window's **Display** pane/window. The data can be recorded to the file specified in the **File Name** and **Directory** text boxes.

When the **Simple GPS Recorder** option is activated, you start and stop the recording manually, by simply clicking the **Start/Stop Recording** button.

File Name: Used to specify the name of the file to which you wish to record the data from the receiver.

Unless a maximum size is selected for the file, you are also allowed to enter an extension into the associated box.

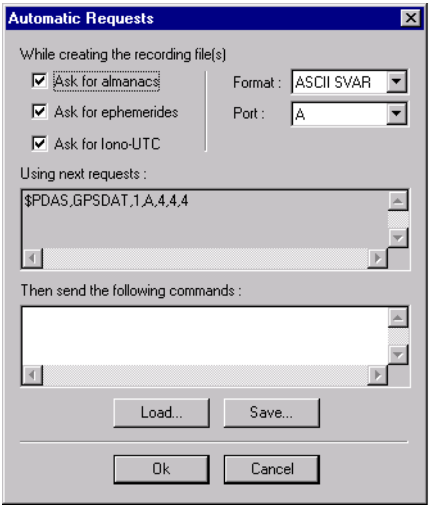
File Max Size: Used to specify whether a single file should be created on the disk (**No Limits** option) or the file should be split into 0.7 MB or 1.4 MB segments with an option to store it on floppy disks.

If you elect to split the file into segments, then the system will automatically add "001" as extension to the name of the first segment. This will automatically be incremented for each file segment generated, if the file exceeds the selected **File Max Size**.

Start Recording: Clicking this button opens a new dialog box in which you can specify which type of raw data you would like to record, if any, before you effectively enable data recording.

(DSNP receivers only) Choose the type of raw data that you would like to insert into the record file(s). Choose also the format for the selected data as well as the port on which the data will be available.

The resulting command ($PDAS or other) is automatically formatted in this area according to your choices



If necessary, edit other commands that you would like the recorder to run after the above one. This requires good knowledge of the different commands possible as well as their syntax. You can save your lists of commands as a BAT file (using the Save button) and load them quickly later on, using the Load button.

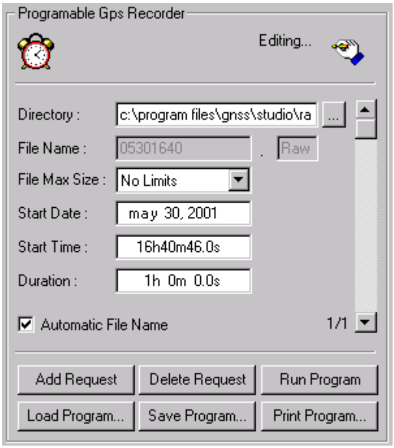
Then click on the **OK** button to start the data recording.

The data recording will take place until you click on the **Stop Recording** button (this button is in fact the **Start Recording** button which is renamed once data recording is in progress).

Programmable GPS recorder

The **Programmable GPS Recorder** option allows you to prepare one or more requests for recording the data output on the connected receiver port, by specifying a start date, time and duration for each planned recording session, and also a disk file name, directory and maximum size.

You can save the recording session requests you prepare (using the **Save** button) so that you can load them back at a later date (using the **Load** button).



Directory: Used to specify the directory to which you wish to record the data from the receiver. Clicking the button to the right opens a dialog box that allows you to navigate through the directory tree on your hard disk or a floppy disk, and select the desired destination directory.

File Name: Used to specify the name of the file to which you wish to record the data from the receiver.

- If you choose the **Automatic File Name** option (i. e. if the option box is checked), then the **File Name** text box is dimmed and the name is automatically assigned by the system, based on the date (month, day number) and time (hour, minute) of the recording session. Example: *12240929* for a file recorded on *December 24* at *9:29* a.m
- If you do not select the **Automatic File Name** option, then you can enter a name of your own. Unless a maximum size is selected for the file, you are also allowed to enter an extension into the associated box.

File Max Size: Used to specify whether a single file should be created on the disk (**No Limits** option) or the file should be split into 0.7 MB or 1.4 MB segments (with an option to store it on floppy disks)

If you elect to split the file into segments, then the system will automatically add “001” as extension to the name of the first segment. This will automatically be incremented for each file segment generated, if the file exceeds the **File Max Size** selected

Start Date: Used to specify the day on which the recording session should begin. The current date is prompted by default

Start Time: Used to specify the time when the recording session should begin. The current time is prompted by default

Duration: Used to specify the planned duration of the recording session

Automatic File Name: If you choose the **Automatic File Name** option (i. e. if the option box is checked), then the **File Name** text box is dimmed and the name is automatically assigned by the system, based on the date (month, day number) and time (hour, minute) of the recording session. Example: *12240929* for a file recorded on *December 24* at *9:29* a.m

If you do not select the **Automatic File Name** option, then you can enter a name of your own. Unless a maximum size is selected for the file, you are also allowed to enter an extension.

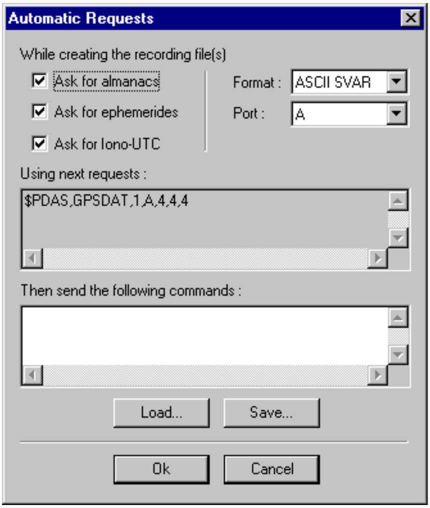
Add Request: This button saves the recording session description currently displayed and increments the number of programmed sessions that appears at the bottom of the scrollbar. (This automatically selects the **Automatic File Name** option and prompts the next possible session, considering the specified duration).

Delete Request: This button deletes the recording session description currently displayed and decrements the number of programmed sessions that appears at the bottom of the scrollbar.

Run Program: This button activates the Programmable GPS Recorder mode. First, a new dialog box appears in which you can specify which type of raw data you would like to record, if any, before you effectively enable data recording.

(DSNP receivers only) Choose the type of raw data that you would like to insert into the record file(s). Choose also the format for the selected data as well as the port on which the data will be available.

The resulting command ($PDAS or other) is automatically formatted in this area according to your choices



If necessary, edit other commands that you would like the recorder to run after the above one. This requires good knowledge of the different commands possible as well as their syntax. You can save your lists of commands as a BAT file (using the Save button) and load them quickly later on, using the Load button.

Then click on the **OK** button. This causes **WinComm** to wait for the next scheduled recording session and perform recording as planned. The label of the button changes from **Run Program** to **Stop Program**. Until the planned recording is complete or you click **Stop Program**, all other buttons in the **Programmable GPS Recorder** pane are inactive and you cannot change to another Mode.

Load Program: This button opens a dialog box that allows you to select a file (typically a .pgm file) containing descriptions of planned recording sessions (saved earlier using the **Save Program** button). Select the desired file name and click **Open**.

Save Program: This button opens a dialog box that allows you to save descriptions of planned recording sessions so that they can be used at a later date (using the **Load** Program button). Enter a name into the **File Name** text box and click **Save**.

Print Program: This button opens a **Print** dialog box that allows you to print the descriptions of planned recording sessions currently loaded.

WinComm shortcut

You can save your customary communications settings to a configuration file and specify the configuration file name in the command line of any shortcut created to start **WinComm**. As a result the configuration file will automatically be loaded and enabled when you double-click the **WinComm** icon to start **WinComm** (in that case the **Communication Settings** dialog box will not be prompted).

To create a **WinComm** shortcut icon that will automatically load one of your customary communications configuration files, do the following:

- With the mouse right button, click outside any window in the workspace. From the menu that pops up, select **New** then **Shortcut**. This opens the **Create Shortcut** dialog box.
- Click the **Browse** button. This opens a dialog box that prompts all the directories existing on your disk. Open (by double-clicking) the directory containing **WinComm**.
- Click **WinComm.exe** and click the **Open** button (or simply double-click **WinComm.exe**). This closes the **Browse** dialog box and automatically enters **WinComm.exe** (with its path) into the **Command line** text box in the **Create Shortcut** dialog box.
- In the **Command line** text box, enter the name of your configuration file after **WinComm.exe**, with a space between **WinComm.exe** and the file name.
- Click the **Next** button. Enter a name for your shortcut icon. Click the **Finish** button. This closes the **Create Shortcut** dialog box.

As a result, a new **WinComm** icon appears in the workspace, with the name you specified. ❑

Appendix C: Geoids Utility

Introduction

Geoids allows the following:

- Importing new geoid models
- Extracting data from a geoid model in order to create a smaller file just describing the specified region
- Loading a geoid model, either partially or completely, into a Spectra Precision receiver. Extracting and loading geoid data can be performed in a single operation.
- Reading the geoid currently used in a receiver (for former "DSNP-type" receivers only).

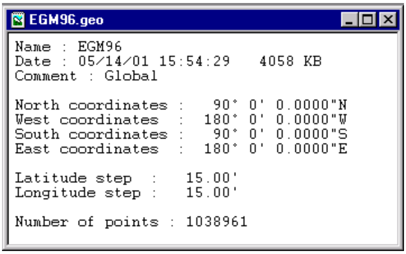
The following formats exist in **Geoids**:

- EGM96
- GEOIDYY
- GGF97
- GGR99
- GRD
- GSD95
- RAF
- AU5 (Australia)
- HBG03 (Belgium), etc.

Opening a Geoid Model

- Select **File>Open**. A dialog box opens in which you can choose a geoid model among those available.
- Choose a model and then click **OK**. A new window appears showing the main characteristics of the chosen geoid (name, date of creation, file size, comment, geographical limits, grid step and number of points).

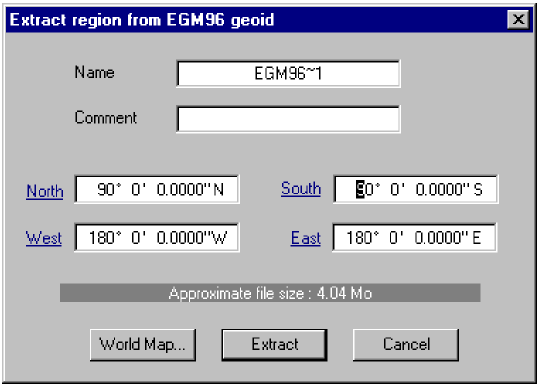
Example of geoid model open in Geoids (EGM96):



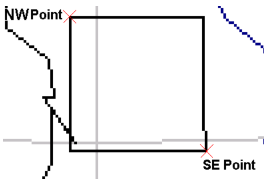
Extracting a Region from a Geoid Model

1. Select **File>Open** and choose the geoid model from the displayed list. **Geoids** will extract the data for your region from this model. Then click **OK**. The selected model appears in **Geoids.**
2. Select **File>Extract As...**. A new dialog box is displayed in which you can define the geographical area you are interested in.

Definition box for data extraction from a geoid model:



3. Define the following parameters:
   - File name (8 characters max.) (Default: <Geoid model name>~#)
   - Comment (25 characters max.). It will appear in the 3rd line when you open the geoid model.
   - Geographical limits of the considered region, necessarily a rectangular area defined by a North-West point (NW) and a South-East point (SE).



   Define the NW & SE points manually, by entering their latitudes & longitudes in the corresponding fields, or graphically using the World Map editor. If you enter the coordinates manually, then go directly to point 4. below.
   - To use the World Map editor rather than enter the coordinates manually, click on the **World Map** button.

   The World Map editor shows the planet Earth. From this view, you can select any region on the surface of the Earth for which you would like to extract geoid data. The World Map editor is equipped with a number of functions allowing you to access this region:

   Globe Viewing Options:
   - Position the mouse pointer anywhere on the globe
   - Right-click on the mouse and choose **Options**. A dialog box opens in which you can change the globe viewing options.

Rotating the Earth:

If the visible part of the World Map editor does not show the desired region, do the following:

- Position the mouse cursor anywhere on the globe
- Right-click on the mouse and select **Grabber**.

  The mouse pointer now looks like this: 
- Hold down the mouse left button and drag in the direction that would bring the desired region on the visible part of the globe. When you release the mouse button, this will cause the globe to rotate around its axis by an angle proportional to the distance traveled by the mouse pointer while dragging.

Zooming in:

- Position the mouse pointer anywhere on the globe
- Right-click on the mouse and choose Zoom in.
- The mouse pointer now looks like this: 
- Position the mouse pointer on the globe where you would like to zoom in, and then click on the left button. This causes the region to be magnified. The center point of the magnified view is in fact the point where you have just clicked

  You can repeat this operation several times (as long as the mouse pointer is a "+" magnifying glass). From the initial view showing all the globe, up to 6 successive zoom-in operations can be performed.

Zooming out:

- Position the mouse pointer anywhere on the globe
- Right-click on the mouse and choose **Zoom out**.

  The mouse pointer now looks like this: 

- Position the mouse pointer on the globe where you would like to zoom out, and then click on the left button. This causes the region to be reduced in size. The center point of the reduced view is in fact the point where you have just clicked.

  You can repeat this operation several times until the entire globe can be seen on the screen.

Selecting a region:

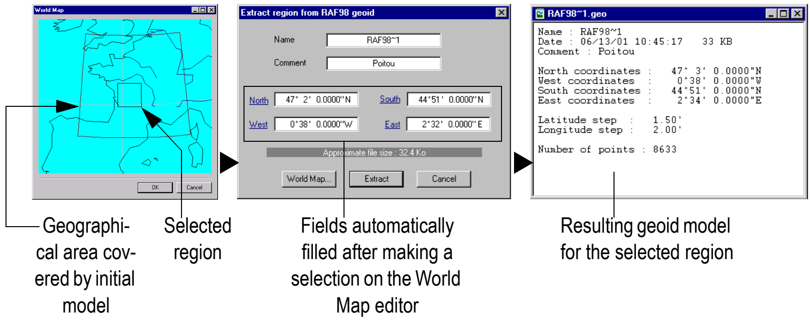
Once the globe is large enough to make a visual estimate of the desired region on the globe's surface, do the following:

- Position the mouse pointer anywhere on the globe
- Right-click on the mouse and choose **Draw**.

  The mouse pointer now looks like this: +
- Position the mouse pointer on the upper-left point of the desired region, drag the mouse down to the lower-right point of the region and then release the mouse. You can now see the desired region inside a rectangle.
- Click **OK**. This closes the World Map window and, in the Extract region from... dialog, you can now see the coordinates of the two points defining the region.

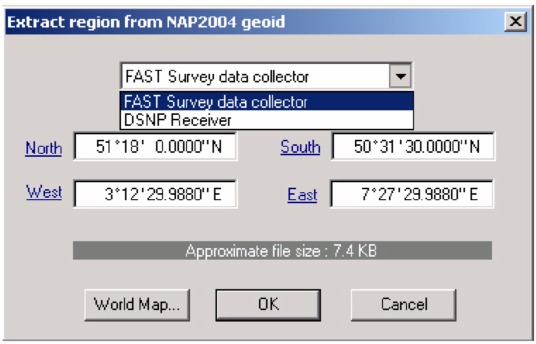
4. Click on the **Extract** button to extract the data from the geoid model for the concerned region. The resulting file is automatically opened in the **Geoids** window once it has been created.

Example of data extraction using the World Map editor:

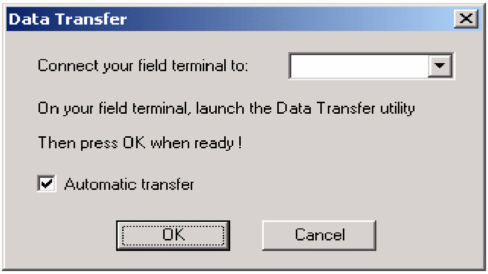


Uploading a Geoid Model into a System

- Open the desired geoid model in **Geoids**
- Select **Transfer>Write**. A dialog box appears asking you to specify the type of system attached to the PC and possibly to extract geoid data from the open geoid model:



- Choose the option corresponding to the system you are using. If you are using a Z-Max, a ProMark3 or ProMark 500, select **FAST Survey data collector**. If you are using a system from the 6000 or 6500 series, select **DSNP Receiver**. Then, if necessary, extract the data from the open geoid model that matches the geographical area you are working in. Use the **World Map** button, as explained on the previous page, to define this area. For your information, the amount of data resulting from the extraction is displayed in the dialog box.
- Click **OK** to upload the geoid data to the system. Depending on which system you are using, the following then occurs:
  - If you are using a Z-Max or ProMark 500, the following dialog box opens:

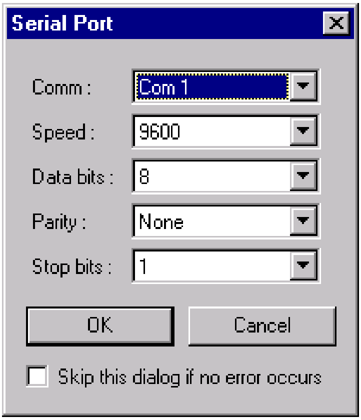


Make sure the data collector is connected to your office computer via a serial line. On the data collector side, run FAST Survey. On the **File** tab, select the **Data Transfer** function and then run **SurvCADD/Carlson Survey Transfer**. The data collector should now display "…Awaiting Connection". On the PC side, select the port used in the combo box and keep the **Automatic Transfer** box checked. Then click **OK** to start the data transfer.

Should the Geoids module fail to connect to the field terminal, please resume the above procedure in Manual Mode, i.e. clear the Automatic transfer *check box when Geoids displays the above dialog box. This will open the Surv-Com window. From this window, you will be able to check the PC port settings (cf.* Options *button), try again to connect to the field terminal (cf.* Connect *button) and then, if the connection is successful, resume data transfer (cf.* Transfer *button). In that case, the file that you would have to select in the left-hand pane before clicking the* Transfer *button would be in the form "<Geoid>.gsf" where <Geoid> is the name of the open geoid model (This file contains the geoid data). The left-hand pane would be automatically positioned on the Temp folder where this file would have temporarily been stored.*

In case of communication failure (and before you acknowledge the error message), the required GSF file is available in your Windows Temp folder and can be copied into an SD card using Windows Explorer.

- If you are using a receiver from the 6000, 6500 or Aquarius series, the following dialog box opens:



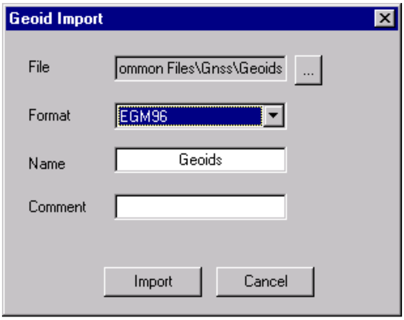
First make sure the 6000, 6500 or Aquarius receiver is connected to the office PC via one of its serial port. After setting the PC port involved in the data transfer in the above dialog box, click OK to upload the geoid data to the receiver.

Importing a New Geoid Model

This function allows you to update any geoid model whose data format is known. **Geoids** will convert any type of file you import into a binary file with GEO extension.

- Select **File>Import**. A dialog box opens allowing you to specify the location of the original file containing the new geoid, its format, the name of the GEO file that will result from the import operation, and a comment associated with the imported geoid model.
- Click on the **Import** button to import the selected geoid model.

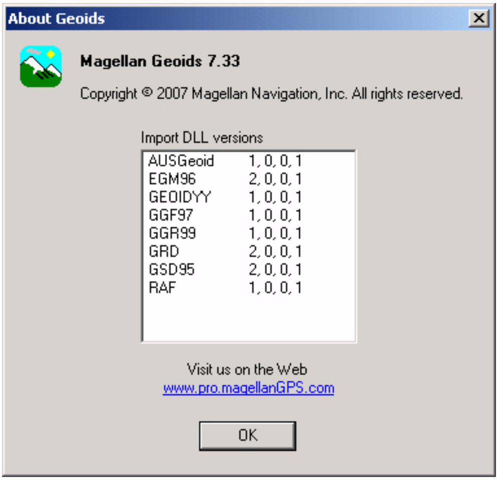
  Example of Import dialog box:



Displaying the Versions of the Available Geoid Formats

- Select **Help>About Geoids...** A dialog box opens listing the versions of the DLL files corresponding to the available geoid models.

  Dialog box showing the available geoid models:



Deleting a geoid model

- Select **File>Open**. A dialog box opens allowing you to specify which geoid model should be deleted (a complete or partial one)
- Click **Delete**. The geoid file is deleted after user confirmation. ❑

Appendix D: Rinex Converter

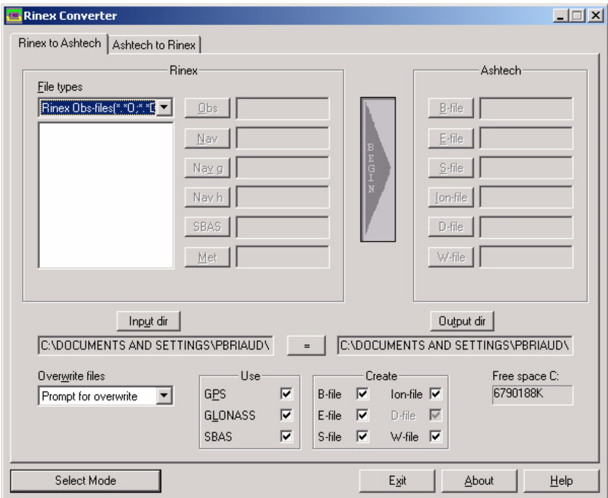
Introduction

Rinex (Receiver INdependent EXchange) is a standard format for GPS, GLONASS and SBAS data supported throughout the industry.

The Rinex Converter utility provides a means to translate single or multiple Rinex-formatted data files from any receiver to Ashtech- or Atom-formatted files, and, alternatively, convert Ashtech or Atom data files to Rinex format. Rinex Converter supports Rinex format versions 2.11 and 3.00 and compact Rinex format version 2.00.

❑ Starting Rinex Converter

- From the Windows task bar, select successively **Start>Programs>GNSS Solutions>Tools>RINEX Converter** or click on **RINEX Converter** in the Utilities topic. The Rinex Converter dialog box opens (see figure below).



❑ Choosing a Conversion Pair

- Click on the **Select Mode** button at the bottom of the window and select the type of format conversion you wish to run. There are three possible choices, each corresponding to a specific conversion pair:
  - Rinex <---> Ashtech
  - Rinex <---> Atom
  - Atom <---> Ashtech

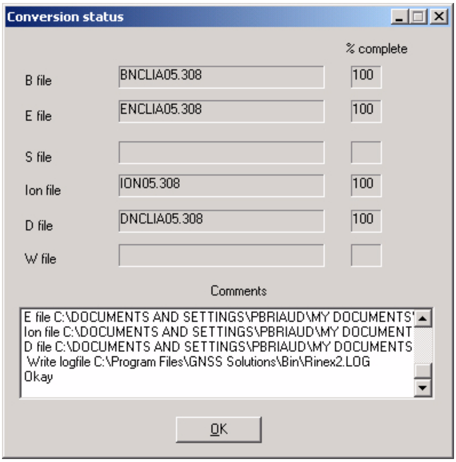
❑ Overwrite Options

Whatever the conversion mode used, overwrite options are available to let Rinex Converter automatically delete files from the output directory according to your choices. In the Rinex Converter window, use the **Overwrite files** option to set your choice before every conversion. The table below summarizes the possible choices.

Option	Definition
Always over-write	This option always writes over existing files with a new file.
Prompt for over-write	(Default setting). If Rinex Converter detects that a converted file has the same name as an existing file, meaning the new file will overwrite the existing file, a dialog box asks if you wish to overwrite the existing file. If you click NO, Rinex Converter skips the file, and continues to the next file.
Never overwrite	This option does not overwrite data for a given file if a file with the same name already exists.

❑ Conversion Status Dialog Box

Whatever the conversion mode used, a conversion status dialog box opens whenever you start a new conversion.



The Conversion status dialog box shows the status of each file as it is converted. Upon completion, the display indicates 100% for each file (see screen example above), or 0 if a file was not converted for lack of data. During conversion, you can:

- Click **Cancel** to cancel the conversion to the current file type and proceed to the next file type
- Click **Cancel All** to cancel the entire conversion.

Once conversion is complete (if you let Rinex converter complete the work), click **OK** to close the **Conversion status** dialog box.

A “*.log” file is created in the directory containing all conversion activity. When restarted, Rinex converter overwrites the existing log file. To save the old log file, rename or move the file before restarting Rinex Converter.

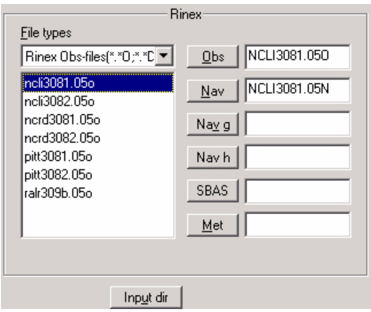
❑ Rinex Format

- The table below summarizes the different types of existing files in the Rinex format.

Item	Description
Obs	Observation data file
Nav	Navigation data file
Nav g	GLONASS navigation data file
Nav h	Ephemeris data file (geostationary satellites)
SBAS	SBAS data file
Met	Meteorological data file

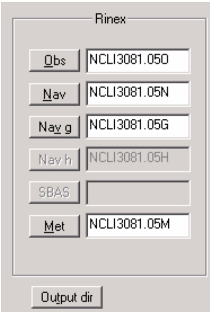
- When a Rinex file is selected at the input of the Rinex converter, Rinex Converter analyzes the other files in the input directory and lists all the files that should logically be converted at the same time. The file analysis is based on file names.

  In the screen example below, Rinex Converter is asked to list all the "*.*O" files present in the input directory. In the resulting left-hand list, the first *.*O file is highlighted to be converted. As a result, in the right-hand part of the screen, Rinex Converter lists all the files that should normally be converted, i.e. the selected Obs file (ncli3081.05O) plus the corresponding Nav file (ncli3081.05N).



  In case Rinex Converter makes a wrong association, you can still change a selected file by clicking on the corresponding button, before the filename, and selecting the right file from the input directory.

- Conversely, when Rinex is the output format, Rinex Converter will suggest that the same types of files be created, depending on the content of the input data set and your current settings in the **Use** and **Create** subsets. Rinex Converter will prompt default names for these files, which we recommend not to change. Below is an example of Rinex files Rinex Converter can generate.



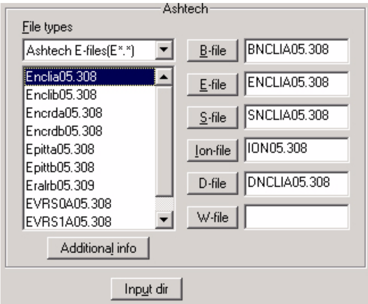
❑ Ashtech Format

- The table below summarizes the different types of existing files in the Ashtech format.

Item	Description
B-File	Raw data file
E-File	Ephemeris data file
S-File	Site information file
Ion-file	Ionospheric data file
D-file	Event data file
W-file	SBAS data file

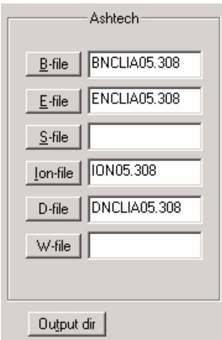
- When an Ashtech file is selected at the input of the Rinex converter, Rinex Converter analyzes the other files in the input directory and lists all the files that should logically be converted at the same time. The file analysis is based on file names.

In the screen example below, Rinex Converter is asked to list all the "E*.*" files present in the input directory. In the resulting left-hand list, the first E*.* file is highlighted to be converted. As a result, in the right-hand part of the screen, Rinex Converter lists all the files that should normally be converted, i.e. the selected E-file (Enclia05.308) plus the corresponding B-file (bnclia05.308), S file (Snclia05.308), Ion-file (ION05.308) and D-file (Dnclia05.308).



In case the converter makes a wrong association, you can still change a selected file by clicking on the corresponding button before the filename and selecting the right file from the input directory.

- Conversely, when Ashtech is the output format, Rinex Converter will suggest that the same types of files be created, depending on the content of the input data set and your current settings in the **Use** and **Create** subsets. Rinex Converter will prompt default names for these files, which we recommend not to change. Below is an example of Ashtech files Rinex Converter can generate.



❑ Atom Format

The Atom format only uses a single file type, as shown in the table below.

Item	Description
G-File	Compiled data file

Compared with the Rinex or Ashtech format, the Atom format is easier to handle. As there cannot be a "companion" file to an Atom file, Rinex Converter will operate as follows with this format:

- When Atom is the chosen input format, no file other than the selected one needs to be converted.
- When Atom is the chosen output format, Rinex Converter can only generate a single "G*.*" file.

❑ Setting the Input and Output Directories

For each conversion pair you will be using, it is a good idea to set the directories Rinex Converter will use as input and output directories.

The input directory is where the files to be converted are stored. The output directory is where Rinex Converter will store the converted files. Each data format should have its specific input and output directories.

First of all you should create input and output directories for each format. For example you could name these directories as follows:

- **Ashin** for all input files in Ashtech format
- **Ashout** for all files converted to Ashtech format
- **Atomin** for all input files in Atom format
- **Atomout** for all files converted to Atom format
- **Rinexin** for all input files in Rinex format
- **Rinexout** for all files converted to Rinex format.

Then, to set the input directory for each conversion pair:

1. Click **Input dir** to open the Set input directory dialog box.
2. Navigate to the directory where the input files are located.
3. Click **Save**. This closes the **Set input directory** dialog box. In its left-hand part, the Rinex Converter window now lists the files from the selected directory as well as the path to this directory. If the source format is Rinex or Ashtech formats, the names of the "companion" files relevant to the file selected by default will also be displayed.

   *If you are converting Rinex files translated from a Rinex converter that does not use the standard Rinex naming format, the observation files may not have the format *.*O. If the files are not listed in the Available Files list, change the* **File Types** *to* **All files** *on the* **Rinex to Ashtech** *or* **Rinex to Atom** *tab and* **ALL files** *in the* **Set input directory** *dialog box.*

To set the output directory for each conversion pair:

1. Click **Output dir** to open the Set output directory dialog box:
2. Navigate to the directory where you want to store the converted files.
3. Click **Save**. This closes the **Set Output directory** dialog box. In its right-hand part, the Rinex Converter window now prompts names for the files that will result from the conversion of the selected input file and its possible companion files.

❑ Batch Processing

To convert more than one file at a time:

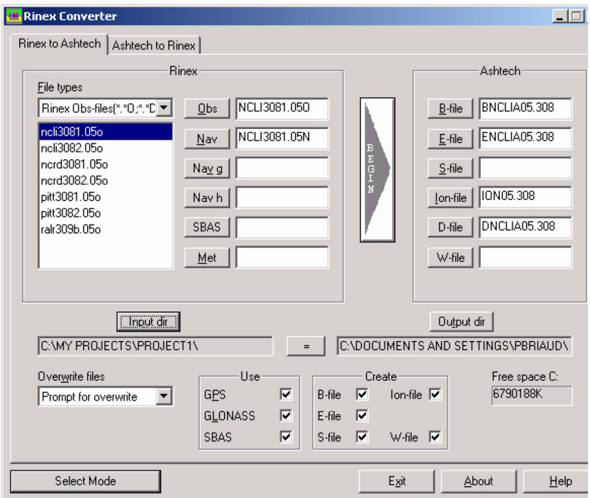
- If the input files are contiguous, hold down the **Shift** key, select files with the cursor, and click each file.
- If the input files are scattered throughout the directory, hold down the **Ctrl** key, select files with the cursor, and click each file.

Warning! With several files selected the names of the companion files and those suggested for the converted files **apply to the last input file selected**.

Rinex-Ashtech Conversions

❑ Converting Rinex to Ashtech Format

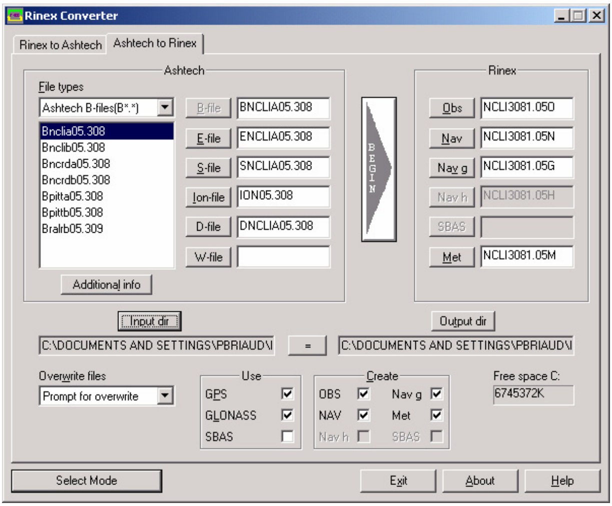
1. In the Rinex Converter dialog box, click on the **Select Mode** button and select **Rinex <---> Ashtech**.
2. Unless already done, set the input and output directories (see *Setting the Input and Output Directories on page 307*).
3. In the left-hand part of the window, select the file you want to convert. For more information on the data displayed in the Rinex subset, refer to *Rinex Format on page 304*.
4. Click the arrow to the right of the **Overwrite files** list, and select an option from the list (see *Overwrite Options on page 302* for more information).
5. Using the check boxes in the **Use** and **Create** subsets, choose the data you want to convert to Ashtech format. In its right-hand part, the Rinex Converter window then prompts names for the files that will result from the conversion, taking into account your “Use” and “Create” settings. See example below.



6. Click **BEGIN** to convert the selected Rinex files to Ashtech format. The **Conversion status** dialog box opens.
7. When the conversion is complete, close the **Conversion status** dialog box.

❑ Converting Ashtech to Rinex Format

1. In the Rinex Converter dialog box, click on the **Select Mode** button and select **Rinex <---> Ashtech**.
2. Click the **Ashtech to Rinex** tab to switch to this tab.
3. Unless already done, set the input and output directories (see *Setting the Input and Output Directories on page 307*).
4. Click the arrow to the right of the **Overwrite files** list, and select an option from the list (see *Overwrite Options on page 302* for more information).
5. In the left-hand part of the window, select the file you want to convert. For more information on the data displayed in the Ashtech subset, refer to *Ashtech Format on page 305*.
4. Using the check boxes in the **Use** and **Create** subsets, choose the data from the selected file(s) you want to convert to Rinex format. In its right-hand part, the Rinex Converter window then prompts names for the files that will result from the conversion, taking into account your “Use” and “Create” settings. See example below.



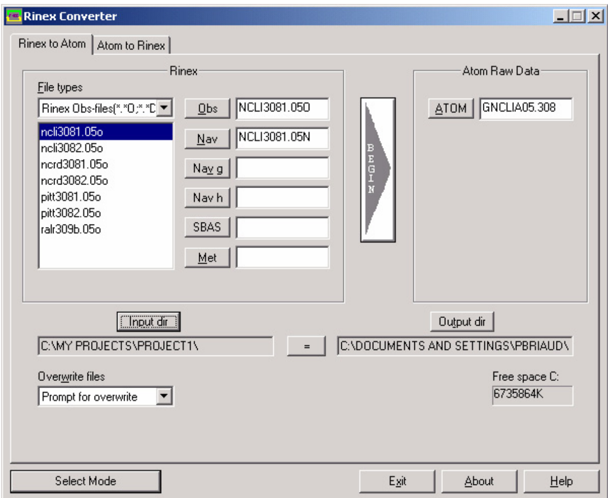
6. Click **BEGIN** to convert the selected Ashtech files to Rinex format. The **Conversion status** dialog box opens.
7. When the conversion is complete, close the **Conversion status** dialog box.

Additional Info button: See *Entering Additional Information Before Converting to Rinex on page 316*.

Rinex-Atom Conversions

❑ Converting Rinex to Atom Format

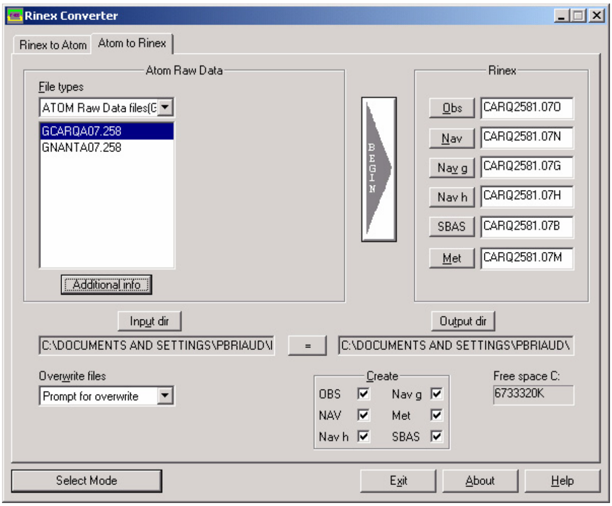
1. In the Rinex Converter dialog box, click on the **Select Mode** button and select **Rinex <---> Atom**.
2. Unless already done, set the input and output directories (see *Setting the Input and Output Directories on page 307*).
3. In the left-hand part of the window, select the file you want to convert. For more information on the data displayed in the Rinex subset, refer to *Rinex Format on page 304*. In its right-hand part, the Rinex Converter window then prompts the name for the file that will result from the conversion. See example below.



4. Click the arrow to the right of the **Overwrite files** list, and select an option from the list (see *Overwrite Options on page 302* for more information).
5. Click **BEGIN** to convert the selected Rinex files to Atom format. The **Conversion status** dialog box opens.
6. When the conversion is complete, close the **Conversion status** dialog box.

❑ Converting Atom to Rinex Format

1. In the Rinex Converter dialog box, click on the **Select Mode** button and select **Rinex <---> Atom**.
2. Click the **Atom to Rinex** tab to switch to this tab.
3. Unless already done, set the input and output directories (see *Setting the Input and Output Directories on page 307*).
4. In the left-hand part of the window, select the file you want to convert. For more information on the data displayed in the Atom subset, refer to *Atom Format on page 307*.
5. Click the arrow to the right of the **Overwrite files** list, and select an option from the list (see *Overwrite Options on page 302* for more information).
6. Using the check boxes in the **Create** subset, choose the data from the selected file(s) you want to convert to Rinex format. See example below.



In its right-hand part, the Rinex Converter window then prompts names for the files that will result from the conversion, taking into account your “Create” settings.

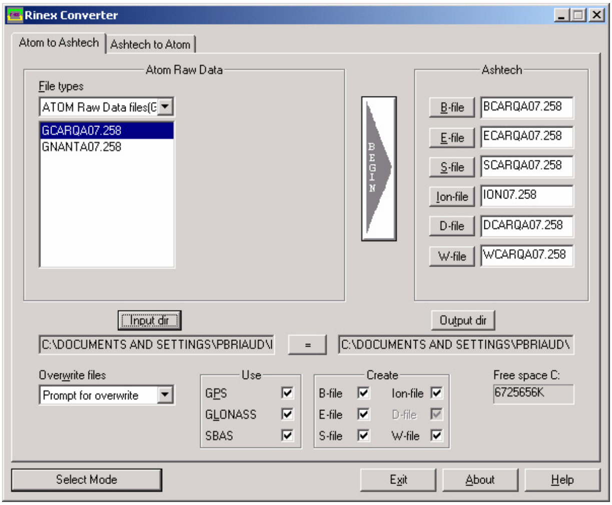
7. Click **BEGIN** to convert the selected Atom file to Rinex format. The **Conversion status** dialog box opens.
8. When the conversion is complete, close the **Conversion status** dialog box.

Additional Info button: See *Entering Additional Information Before Converting to Rinex on page 316*.

Ashtech-Atom Conversions

❑ Converting Atom to Ashtech Format

1. In the Rinex Converter dialog box, click on the **Select Mode** button and select **Atom <---> Ashtech**.
2. Unless already done, set the input and output directories (see *Setting the Input and Output Directories on page 307*).
3. In the left-hand part of the window, select the file you want to convert. For more information on the data displayed in the Atom subset, refer to *Atom Format on page 307*.
4. Click the arrow to the right of the **Overwrite files** list, and select an option from the list (see *Overwrite Options on page 302* for more information).
5. Using the check boxes in the **Use** and **Create** subsets, choose the data from the selected file you want to convert to Ashtech format. In its right-hand part, the Rinex Converter window then prompts names for the files that will result from the conversion, taking into account your “Use” and “Create” settings. See example below.

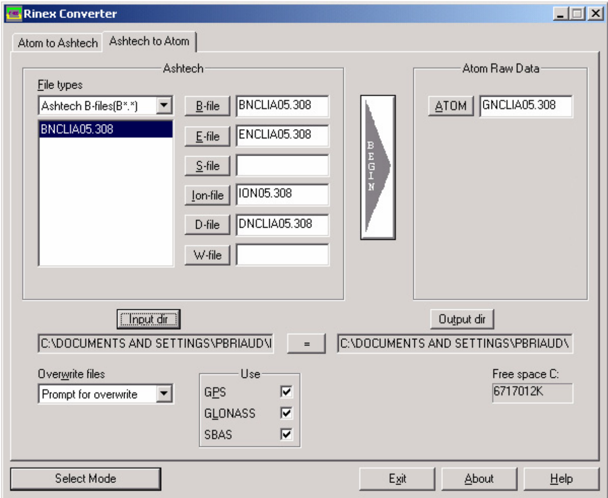


6. Click **BEGIN** to convert the selected Atom file to Ashtech format. The **Conversion status** dialog box opens.
7. When the conversion is complete, close the **Conversion status** dialog box.

❑ Converting Ashtech to Atom Format

1. In the Rinex Converter dialog box, click on the **Select Mode** button and select **Atom <---> Ashtech**.
2. Click the **Ashtech to Atom** tab to switch to this tab.
3. Unless already done, set the input and output directories (see *Setting the Input and Output Directories on page 307*).
4. In the left-hand part of the window, select the file you want to convert. For more information on the data displayed in the Ashtech subset, refer to *Ashtech Format on page 305*.
5. Click the arrow to the right of the **Overwrite files** list, and select an option from the list (see *Overwrite Options on page 302* for more information).

6. Using the check boxes in the **Use** subset, choose the data from the selected file(s) you want to convert to Atom format. In its right-hand part, the Rinex Converter window then prompts names for the files that will result from the conversion, taking into account your "Use" settings. See example below.

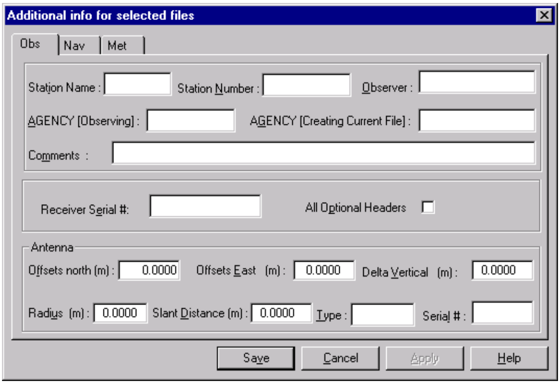


7. Click **BEGIN** to convert the selected Ashtech file to Atom format. The **Conversion status** dialog box opens.
8. When the conversion is complete, close the **Conversion status** dialog box.

Entering Additional Information Before Converting to Rinex

Before starting a conversion to Rinex, you may set additional information usually present in the Rinex format. Because the Ashtech and Atom formats do not initially contain this information, you may add it manually using the procedure below, provided this information is available:

1. Click **Additional Info** and select the **Obs** tab:



2. Complete the fields in the **Obs** tab. The information entered in the **Obs** dialog box is stored in the observation data file. The table below describes each field.

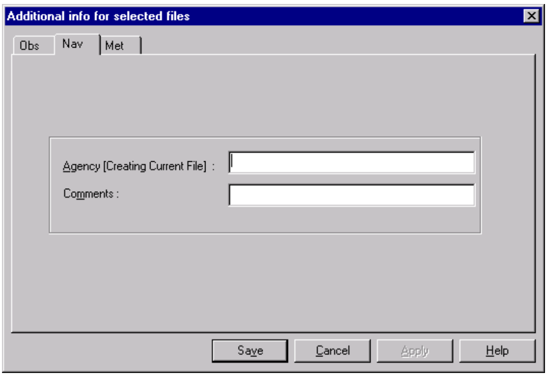
Field	Description
STATION INFORMATION	
Station Name	Name of the survey point or station where data was collected.
Station Number	Number of the survey point or station where data was collected.
Observer	Name or code of the surveyor who collected the data.
AGENCY (Observing)	Name of the company or agency who collected the data.
AGENCY (Creating Current File)	Name of the company or agency who converted the data to Rinex.
Comments	Any comments pertaining to the station, data quality, cover, GPS/GLONASS, etc. 50-character length limit.
RECEIVER INFORMATION	
Receiver Serial #	Serial number of the receiver that collected the data.

All Optional Headers	Check this box if you want all non-mandatory fields to be filled in the Rinex file header.
ANTENNA INFORMATION	
Offsets north (m)	Horizontal distance, in meters, that the antenna is offset from the marker in the north/south direction. + is north, - is south.
Offsets East (m)	Horizontal distance, in meters, that the antenna is offset from the marker in the east/west direction. + is east, - is west.
Delta Vertical (m)	True vertical distance, in meters, between the bottom of antenna and the marker.
Radius (m)	Radius of the antenna in meters.
Slant Distance (m)	Measured distance, in meters, from the edge of the antenna to the marker. If a value for an antenna are entered, it over writes the values in the S-file.
Type	Type of antenna used in data collection.
Serial #	Serial number of antenna used for data collection.

3. Click **Apply** to save the changes made to the **Obs** tab, and click **Nav** to switch to the **Nav** tab (see figure below).

   You can enter information for all three tabs and save all the data using the **Save** *button. The best practice, however, is to save the data using the* **Apply** *button for each tab immediately after entering the data in case of a computer or power failure.*

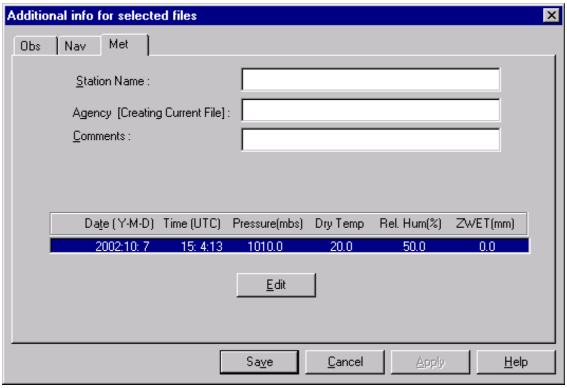
   The **Save** *button saves the data entered on the active tab only, and closes the* **Additional info for Selected Files** *dialog box.*



4. Complete the fields in the **Nav** dialog box. The information entered in the **Nav** dialog box is stored in the navigation data file. The table below describes each field.

Field	Description
Agency (Creating Current File)	Name of the company or agency who converted the data to Rinex.
Comments	Any comments pertaining to the station, data quality, cover, GPS/GLONASS, etc. 50-characters maximum.

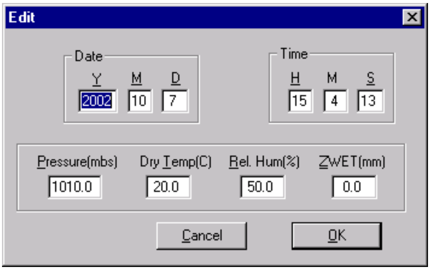
5. Click **Apply** to save the changes made to the **Nav** dialog box, and click on the **Met** tab to switch to this tab:



6. Complete the fields in the **Met** dialog box. The information entered in the **Met** dialog box is stored in the meteorological data file. The table below describes each field.

Field	Description
Station Name	Name of the survey point or station where data was collected.
Agency (Creating Current File)	Name of the company or agency that converted the data to Rinex.
Comments	Any comments pertaining to the station, data quality, cover, GPS/GLONASS, etc. 50-character limit.
Meteorological Data List	Date and time atmospheric data was collected (atmospheric pressure, temperature, relative humidity, and ZWET (Zenith Wet Tropospheric Delay).
Edit	Click this button to open the Edit dialog box and edit the selected meteorological data line.

7. Click **Edit** to open the **Edit** dialog box and inspect or change the meteorological data:



8. Enter the meteorological data, the date and the UTC time that the data was taken, and click **OK**. The table below describes the fields in the **Edit** dialog box.

Field	Description
Date	The year, month, and date that the data was recorded. D is the day of the month (not Julian day) the data was recorded.
Time	The time the data was recorded. H is the hour of the day the data was recorded in UTC time (24 hour time scale) M is the minute of the hour the data was recorded in UTC time. S is the second of the minute the data was recorded in UTC time
Pressure (mbs)	The recorded barometric pressure of the atmosphere in millibars.
Dry Temp (C)	The recorded temperature of the air not corrected for humidity, in degrees Celsius.
Rel. Hum (%)	The recorded relative humidity of the air in percent.
ZWET (mm)	Zenith Wet Tropospheric Delay—in millimeters (default = 0)

9. Click **OK** to accept the meteorological data and close the **Edit** dialog box.
10. Click **Save** to save the changes made to the **Met** tab and close the **Additional info for selected files** dialog box.
    - The **Apply** button saves any changes made to the active tab, and does not close the **Additional info for selected files** dialog box.
    - The **Save** button saves any changes made any tab, and closes the **Additional info for selected files** dialog box. ❑

Appendix E: DTR Utility

Introduction

DTR is used to convert DSNP-formatted raw data files into Observation + Navigation files in RINEX format.

❑ Input files

Input files should be DSNP raw data files containing binary or ASCII data.

❑ Time labeling

Format conversion involves changing the time-labeling of the raw data. This operation is required as the DSNP format is based on satellite time whereas the RINEX format uses receiver time.

Time-labeling is changed through extrapolation.

❑ Naming the output files

The output files can be named freely, or using the conventions defined in the RINEX format, namely:

<site_name><log_day><file_index>.<log_year><type_code>

where:

<site_name>: the first 4 characters from the name of the site where raw data was logged

<log_day>: log day in 3 figures (1 to 365)

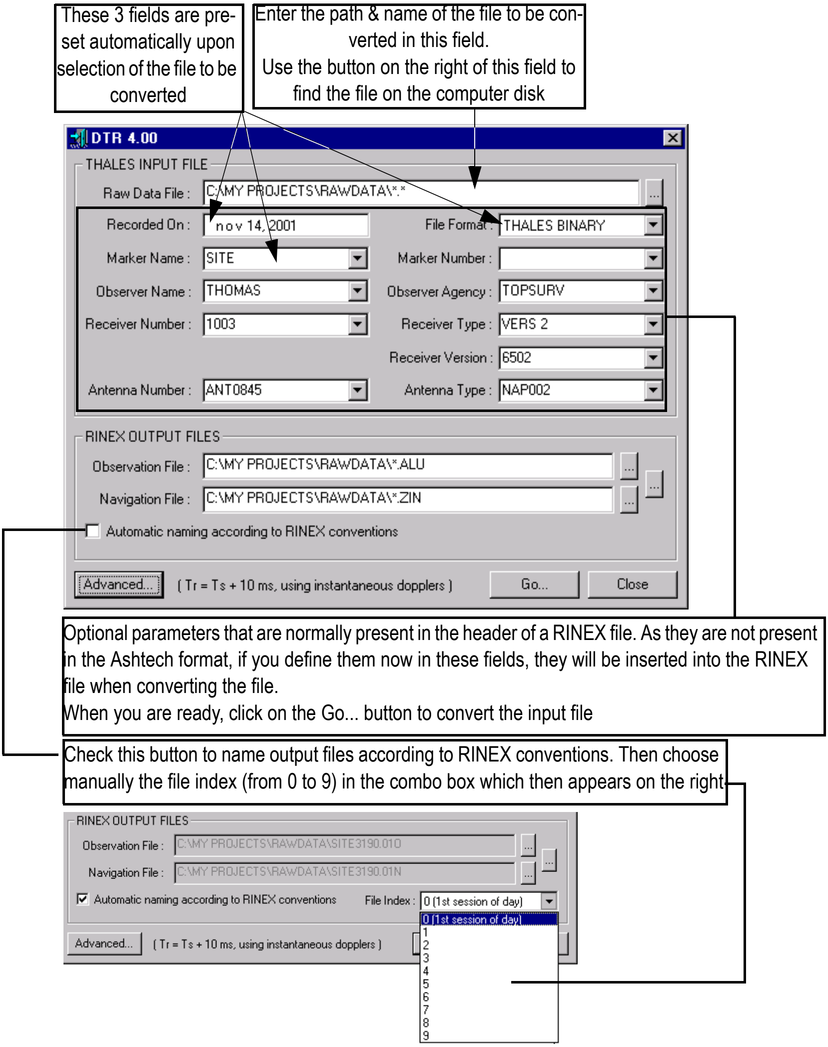
<file_index>: a figure from 0 to 9 allowing you to create up to 10 different files for the same log date and the same site

<log_year>: log year in 2 figures (example: 2001→ 01; 1998→ 98)

<type_code>: letter "O" for Observation file, or "N" for Navigation file.

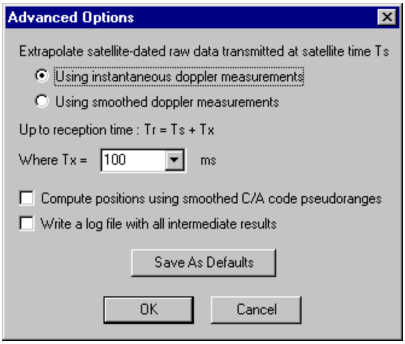
Using DTR

❑ Description of the main window



❑ Advanced options

This window is displayed after clicking on the **Advanced** button in the main window. It is used to define precisely in which way time-labeling is changed from satellite to receiver time.



For a standard conversion, use instantaneous dopplers and Tx=0.

To optimize further processing of files in RINEX format originating exclusively from DSNP log files, use Tx=75 ms preferably. In addition, to optimize static processing, choose filtered dopplers preferably.

75 ms stands for the average propagation time of GPS signals between any satellite and any receiver on Earth. It is therefore the best value a priori to use in the conversion. ❑

Appendix F: Download Utility

Introduction

This module is used to download data from the data memory card installed in the receiver, or from the data card inserted in the local card reader, or directly from a receiver or the PC hard disk. The data card contains data logged during your field surveys.

Download should not be confused with the **Import Raw Data from Files or ProMark 500** command from the **Project** menu in GNSS Solutions. This last command can only import pre-converted data files, ready for processing, whereas the Download module is used to download AND convert the raw data files that come direct from the field and that need to be split up into several files before GNSS Solutions can process them.

You can download data files to a project only after opening this project, which means you must create the project first. As explained above, data files are located either on a data card still present in the receiver or a data card inserted in the local card reader, or on your PC hard disk (if previously downloaded from the receiver).

To add data files to the project, from the land survey project open in GNSS Solutions, use the **Download Raw Data from Z-Max or ProMark3** command from the **Project** menu. This will open the **Download** window from which you will be able to download data.

Data Files

During a data recording session, all the data for that session is stored on the data card as a U-file. The U-file is a compressed file that contains the data that is converted to individual files during the download process. These files include: the raw data file (B-file) that stores all carrier and code phase data, the ephemeris file (E-file) that stores satellite position and timing information, the site position information file (C-file), the session information file (S-file), the satellite almanach data file (ALM-file), the ionospheric data file (ION-file) and the epoch solution & vector solution information file (T-file). The B-, E-, S- and ALM files are standard files that are recorded during data collection. If the receiver is an RTK rover, the receiver creates and stores a specific file of the T-file type containing CBEN records (RTK epoch solutions) and OBEN records (RTK vector solutions). Lastly, the receiver creates an event file (D-file) if the receiver is collecting attribute or event-driven data.

The table below summarizes the file types, including file names, a description of the information contained in the files, and the file format.

File Type	Description	Format
B-file	Raw code and carrier phase data, range data, clock data	Binary
E-file	Satellite ephemeris and timing data	Binary
S-file	Session information data	ASCII
ALM file	Satellite almanac data	Binary
D-file	Event time tags and data	ASCII
ION-file	Ionospheric data	Binary
T-file	RTK epoch solutions and vectors	Binary
C-file	Site position information	ASCII

Downloading Data From a Z-Max or ProMark3

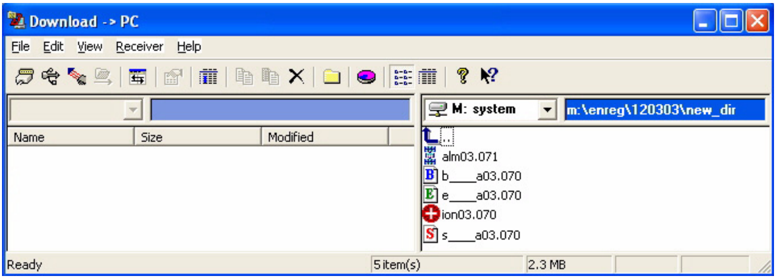
Downloading and adding raw data from a GPS receiver to a project can be made directly in one, easy step by selecting **Download Raw Data from Z-Max or ProMark3** in the **Project** menu of GNSS Solutions. Use this option to insert data directly from the data card residing in a receiver, or the data card removed from the receiver and inserted in the local card reader, or from the hard disk.

If you have the option of removing the data card from the receiver to download the files using a card reader, you must still use Download to convert the files. If you only copy the data from the data card without converting them, GNSS Solutions will not be able to read and import them

If you connect the PC to a receiver via USB, before starting Download, make sure the receiver is turned on, and connected to the PC. Otherwise the **Connect via USB** *button is grayed out.*

1. Connect the receiver to the PC. There are two possible methods to download data: either you connect the receiver via serial port or via USB port. Using USB is recommended as data transmission is much faster in this case. Verify that the power is on.
2. Select **Download Raw Data from Z-Max or ProMark3** from the **Project** menu of GNSS Solutions.

The Download main window appears:



The Download main window consists of two panes. The right pane (the PC (Personal Computer pane) lists the files, if any, in the project directory of the PC. The left pane (currently blank) will list the files on the data card once you have selected the right folder on your PC (case where the data card is inserted in the card reader, or the data file -micro_z.bin for Z-Max- from the data card has already been copied unchanged to the PC hard disk) or once the connection to the receiver is established (case where the data card stays in the receiver).

The table below describes the toolbar buttons:

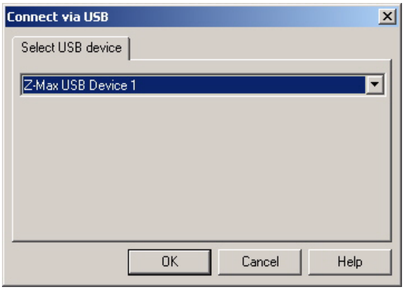
Button	Description
	**Connect via Cable** button - Click this button to open the **Connect via Cable** dialog and connect to the receiver via serial line
	**Connect via USB** button - Click this button to open the **Connect via USB dialo**g and connect to the receiver via USB line
	**Connect via IR** button -
	**Switch Data Source** button - Click this button to open the **Switch Data Source** dia-log and connect to another receiver.
	**Switch Pane** button - Click this button to change the active pane.
	**Session Info** button - Click this button to Open the **Session Information** dialog and set session parameters for the data file.
	**Select Files** button - Click this button to select files based on a file mask. The **Select Files** dialog opens to enter a file mask for file selection.
	**Copy To** button - Click this button to copy the selected file(s) to the current directory on the PC.
	**Move To** button - Click this button to move the selected file(s) to the current directory on the PC.
	**Delete** button - Click this button to delete the selected file(s).
	**Create New Directory** button - Click this button to create a new directory in the cur-rent PC directory.
	**Free Space** button - Click this button to check the available disk space for the current drive or receiver.
	**Brief File Info** button - Click this button to display only the names of the files.
	**Detailed File Info** button - Click this button to display the name, size, date, and time of last modification for each file and directory in the current directory.
	**Help** button - Click this button to access the help system.
	**What's This Help** button - Click this button and anywhere else in the window or menu system for quick help on the feature.

3. Select **Connect** from the **File** menu.

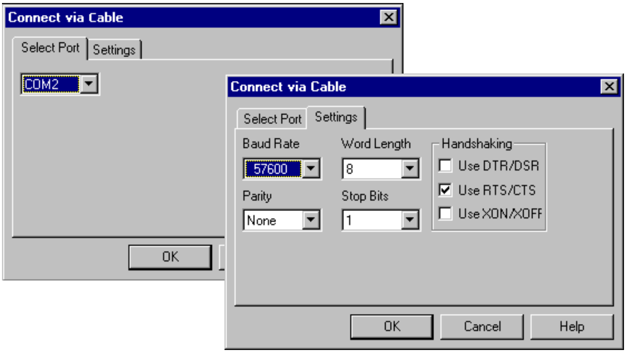
   If you are downloading data from a data card inserted in the card reader of your computer, select **PC Drive** and skip step 4.

   If you are downloading data from a receiver, select **Receiver** and then select **Connect via USB** to connect to the receiver via USB, or **Connect via Cable** to connect to the receiver via an RS232 line.

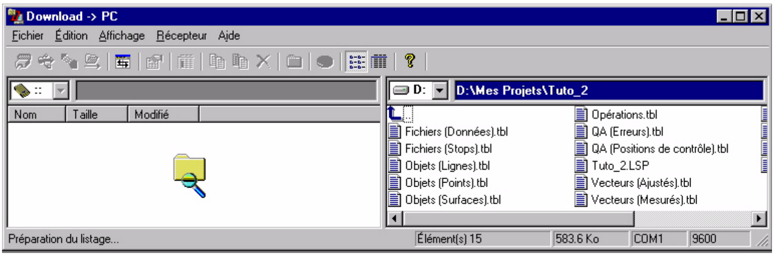
   a) If you choose **Connect via USB**, the **Connect via USB** dialog box opens. If only the Z-Max is connected to the PC via USB, then this dialog box looks like this (and only the option below, “Z-Max USB device1”, is prompted):



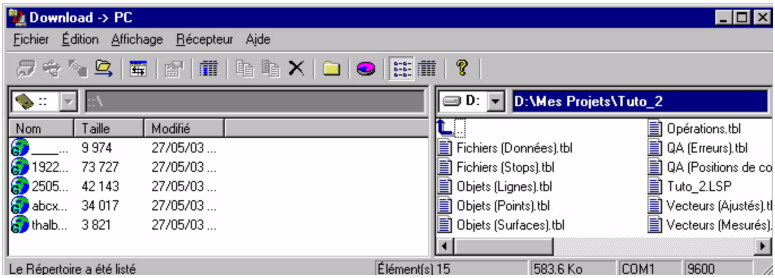
b) If you choose **Connect via Cable**, the **Connect via Cable** dialog box opens. Select the serial port corresponding to your case of use and then choose the right communication parameters on the **Settings** tab:



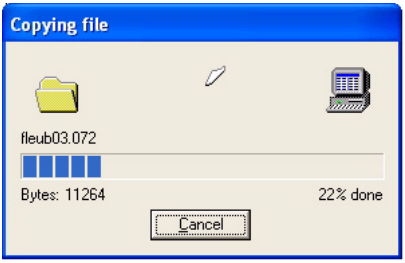
4. Click **OK**. Download makes the connection to display the content of the data card. Before that, and the first time you connect to a data card, Download spends some time mounting the data card file system, as indicated in the lower part of the left pane (this operation may take a while):



After system mounting, the left pane lists the files contained in the data card. Note that the listed U-file names comply with the file naming conventions defined for files present in the data card, except for the leading “U” letter which is replaced here with a globe icon (with a “G” for “Geodetic” inside the globe).



5. Verify that the destination directory in the PC pane is the project directory or the directory where you want the data files to be stored.
6. If you want to create a new directory, click anywhere on the PC pane, then click the **New Directory** button and type a name for the directory. Be sure to use logical and consistent path and file naming conventions that are easy to remember. Usually it is most convenient to put the data files in the project directory.
7. Select the data file(s) that you want to download and drag them to the PC pane. To select a group of contiguous files, hold the **Shift** key while selecting files. To select particular files in the list, hold down the **Ctrl** key while selecting files.
8. Download copies the files to the PC. A progress dialog box indicates the status of the download:



You have now reached the end of the downloading procedure. Although the data files have been downloaded from the receiver, they have not been deleted from the receiver's data card. To delete receiver data files, select the desired files and click the **Delete** button on the toolbar. The **Move** function copies and then deletes the files.

It is good practice to delete the data files in the data card after verifying that the files have downloaded properly. Otherwise, the memory may fill up during the next data collection session, resulting in the inability to complete the survey. ❑

Appendix G: Internet Download

Introduction

This utility program allows you to download RINEX raw data or orbit data from a provider, via the web.

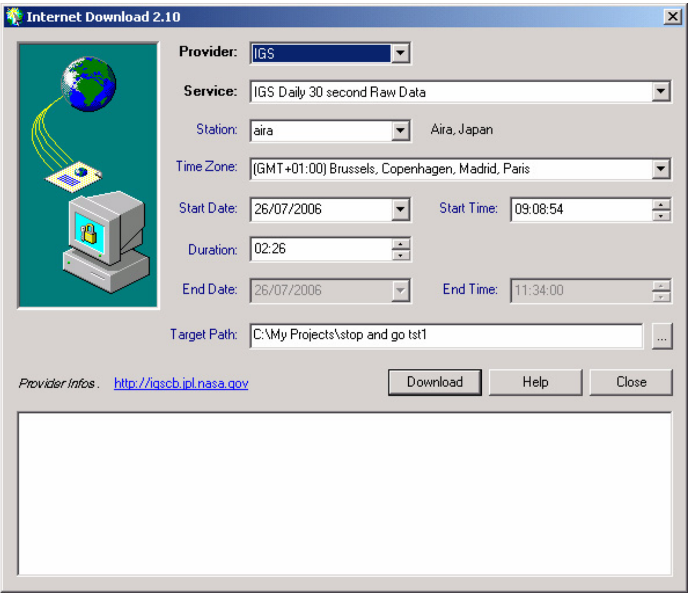
You can use Internet Download in standalone or when importing files to the active project. In the latter case, Internet Download will automatically set the **Start date**, **Start time** and **Duration** fields to fit the observations files you have selected for import. This means Internet Download will by default ask the data provider to send data for the same period of time as the observation files.

To run Internet Download in standalone, just select **Start>Programs>GNSS Solutions>Tools>Internet Download** or click on the **Internet Download** icon in the Utilities topic.

To run Internet Download from the **Importing GPS Data** window, click on the **Add Raw Data** button and then select **Downloaded from Internet**.

You can also run Internet Download by clicking on the **Internet Download** icon in the Import topic. In this case, Internet Download will automatically set the **Start date**, **Start time** and **Duration** fields to fit the observations files present in the open project.

The Internet Download window looks like this:



Using Internet Download

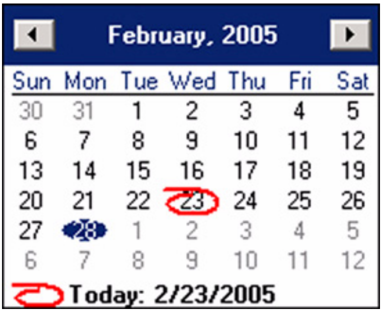
The Internet Download window is organized and should be used as follows:

- **Provider**: Select the name of the provider from which you want to download raw data.
  After making this choice, Internet Download updates the lists of available services and stations attached to respectively the **Service** and **Station** fields underneath.

Also, when you select a provider, the corresponding web address is displayed in the lower part of the window (in underlined blue characters) after the "Provider Infos:" text string. Clicking on this address would launch your Internet explorer to connect to this website.

- **Service**: Choose the type of data you want to download from the selected provider. The list of service names attached to this field is tied to the provider you have selected
- **Station**: Choose the name of the station for which you want to download data. The list of station names attached to this field is tied to the provider you have selected.
- **Time Zone**: Select the option that fits your working area.
- **Start Date**, **Start Time**, **Duration**: These fields allow you to define the period of time for which you want data from your provider. The **End date** and **End time** fields are software set for your information, after you have set these 3 fields.

  To change the Start date, click on the corresponding down-arrow. A calendar is then displayed:



  - Click on the displayed year and use the up/down arrows next to it to set the year
  - Click on the right/left arrow to set the month
  - Click on the day number to set the day. This closes the calendar.
- **Target Path**: This field allows you to define the folder where you want Internet Download to store the downloaded files.

  To do this, click on ..., browse your disk until you can select the desired folder name and then click **OK**. The selected folder and its path will then appear in the **Target Path** field.
- **Download** button: Click on this button when you agree with all the settings in the window and you want to start downloading data. Below is an example of the message lines that appear in the Output pane –located in the lower part of the window– as raw data downloading takes place:

```
Connecting to Host "cddisa.gsfc.nasa.gov"... Ok
Searching for file "/pub/gps/gpsdata/04013/04d/brst0130.04d.Z" ... Ok
Searching for file "/pub/gps/gpsdata/brdc/2004/brdc0130.04n.Z" ... Ok
Downloading File "/pub/gps/gpsdata/04013/04d/brst0130.04d.Z"... Ok
Downloading File "/pub/gps/gpsdata/brdc/2004/brdc0130.04n.Z"... Ok
Disconnecting... Ok
Uncompressing Observation file(s)... Ok
Merging Observation data to "brst0131.04o"... Ok
Uncompressing Navigation file(s)... Ok
Merging Navigation data to "brst0131.04n"... Ok
```

  Note the different operations performed during this phase:
  - Internet Download connects to the Provider's web address
  - Provider then searches for and then download the corresponding files to the specified folder
  - Disconnection from Provider's web address

- Internet Download locally uncompresses and merges the observation files
- Internet Download then locally uncompresses and merges the navigation files.

Below is another example of messages read in the Output pane when downloading orbit data:

Connecting to Host "cddisa.gsfc.nasa.gov"... Ok
Searching for file "/pub/gps/products/1253/igr12532.sp3.Z" ... Ok
Downloading File "/pub/gps/products/1253/igr12532.sp3.Z"... Ok
Disconnecting... Ok

- **Close** button: Click on this button to quit Internet Download.

Adding new Providers to the Existing List of Providers

From version 2.5, this task is supported by GNSS Solutions itself, and no longer by Internet Download, now in version 2.10 (see *Adding a New Provider on page 221*)

Appendix H: SurvCom Utility

Launching SurvCom

SurvCom allows you to exchange data between the office PC and the data collector.

Note that the RTK feature should logically be active in GNSS Solutions when using SurvCom. To activate the RTK feature, select Tools>Preferences in GNSS Solutions and check the Show RTK functions button.

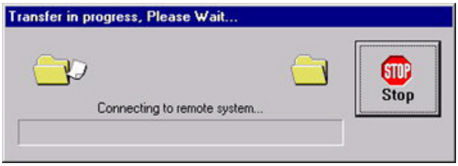
Before running SurvCom, make sure FAST Survey's Data Transfer menu is open on the data collector.

The SurvCom utility is available from the GNSS Solutions tools list. It will also be automatically launched from within GNSS Solutions when you select one of the following commands:

- Upload Positions to External Device (provided you then select data collector as the external device connected to the PC)
- Download Positions from External Device (provided you then choose "real-time results" as the data to be downloaded and you select data collector as the external device connected to the PC).

If the communications parameters are set correctly, a connection will be made and the directory listing from the receiver will be retrieved:

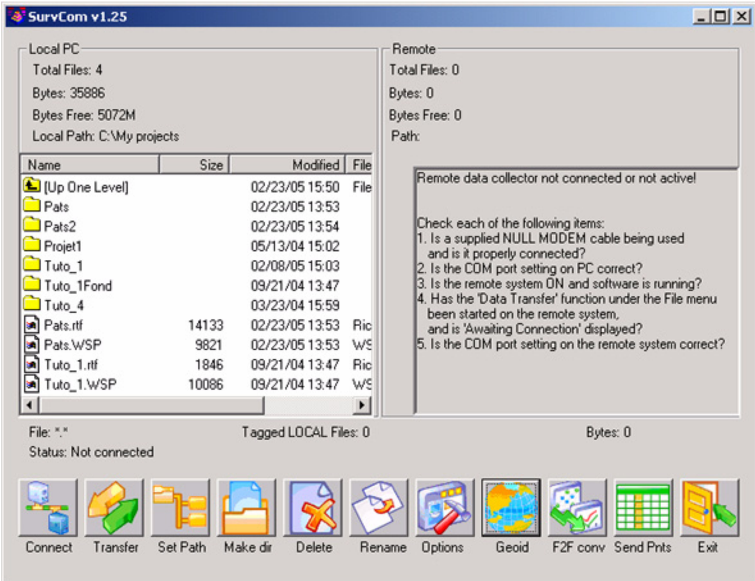
If on the contrary, the parameters are incorrect, the following two dialog boxes will appear, one after the other:



If a connection is not made, the SurvCom window will open anyway, but the program will only be able to display the list on the left showing files and directories from the PC. Click the **Options** button and adjust the COM port and/or baud rate settings to match those of the data collector and press the **Connect** button to try again.

SurvCom Main Window

The SurvCom window looks like this after a connection to an external device is made correctly:



To access a parent directory, double-click the [Up One Level] string. To open a folder appearing in any of the panes, double-click it.

Commands Available

 : **Connect** button

- When launching SurvCom, this button is automatically actuated to try to connect to the external device. As explained earlier, if the connection to this external device fails, click this button to try the connection again. You can change the connection parameters by clicking the **Options** button.

 : **Transfer** button

- This command is used to transfer files.
  The list on the left shows files on the PC. The list on the right shows files on the data collector.
- To move files from one to another, highlight the files and press the **Transfer** button.

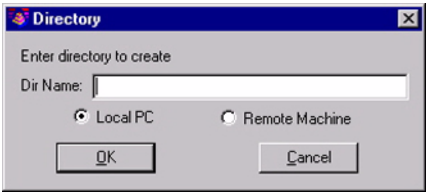
 : **Set Path** button

- This command allows you to set the path on either the local PC or the remote data collector.

- Type in the path you wish to change to, choose Local PC or Remote Machine and then press **OK**.
  You may also change the path by navigating the directory structure shown in the main window of the SurvCom program.

 : **Make Dir** button

- This command allows you to create a directory on either the Local PC or the Remote Machine.



- Type in a directory name you want to create, choose Local PC or Remote Machine and then press **OK**.
  If you enter an invalid directory name, it will not be created. Invalid directory names are determined by the operating system.

: **Delete** button

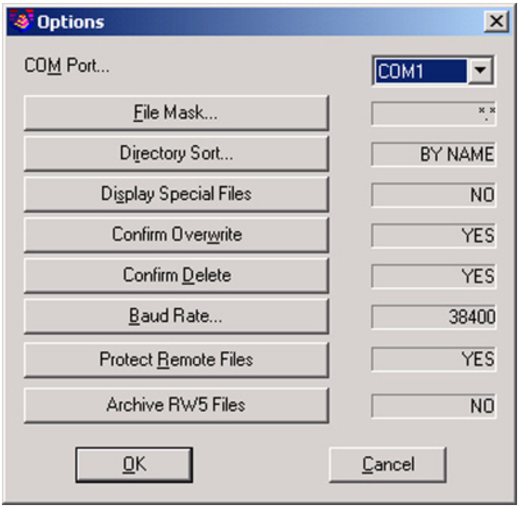
- This command allows you to delete files and empty directories. Click this button after selecting the item(s) you want to delete. Depending on the **Confirm Delete** option chosen with the **Options** button, a message will appear, or not, asking you to confirm deleting these items.

: **Rename** button

- This command allows you to rename files or directories. Click this button after selecting the item you want to rename.

: **Options** button

- This command allows you to set various options. When you click the **Options** button, the following dialog box opens on the screen:



- **Com Port**: You must select which COM port on the PC to use.
- **File Mask**: You must select a file filtering syntax. *.* will show all files.
- **Directory Sort**: You must select how to sort the list of files (by name, date or size, or no sorting).
- **Display Special Files**: Toggle whether or not you should see special files.
- **Confirm Overwrite**: Toggle whether or not you want SurvCom to have you confirm overwriting of files.
- **Confirm Delete**: Toggle whether or not you want SurvCom to have you confirm deleting of files and directories.
- **Baud Rate**: You must choose the baud rate for transferring data (4800, 9600, 19200, 38400, 57600 or 115200).
- **Protect Remote Files**: Toggle whether or not you want to protect files on the mobile device.
- **Archive RW5 files**: Toggle whether or not you want to save the RW5 files

: **Set Geoid** button

- Not used in Spectra Precision applications.

: **F2F Conv** button

- This command will copy a field to finish file (.FLD) to the data collector and convert it to the (.FCL) format used by the FAST Survey field software.

: **Send Pnts** button

- Not used in Spectra Precision applications.

: **Exit** button

- This command will exit SurvCom. ❑

Appendix I: Project Management

Project Management provides an easy way to handle your projects. Because it will always operate on ALL the files and folders pertaining to a project, Project Management gives you the assurance that not a single file will be forgotten. With Project Management, you can:

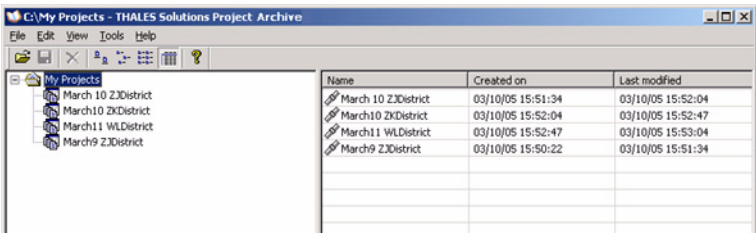
- Back up a project or workspace
- Restore a project or workspace
- Delete a project or workspace

This appendix describes how to use Project Management. For your information, the last section in this appendix tells you what a project is made up of in terms of files and folders and so identifies the items handled by Project Management when you use it.

Main Window

You cannot run Project Management unless GNSS Solutions is inactive. Conversely, you cannot launch GNSS Solutions if Project Management is still running. To run Project Management:

- From the Windows task bar, select **Start>Programs>GNSS Solutions>>Tools>Project Management**. The Project Management main window looks like this:



About Projects and Workspaces

The right part of the window lists all the *projects* saved in the **MyProjects** folder (or in whatever folder you chose at software installation to save your projects).
The left part of the window lists all the *workspaces* saved in your project folder:

- If you are using GNSS Solutions with the default installation, the notions of *workspace* and *project* are merged into a single notion. When in this case of use you create a new project, GNSS Solutions not only creates a project but also a workspace whose name is the same as that of your project. This is the reason why, in this case, the two lists in the Project Management window are alike.
- But if you are using GNSS Solutions with the "Data Management" option running and you have used the notion of *workspace* to group several *projects*, then the two lists will be different. If you move the mouse cursor over the list of workspaces, a tip box will appear for each workspace indicating the number of projects grouped in the workspace. Conversely, the tip boxes attached to the list of projects will tell you, for each project, the number of workspaces in which the project is involved.

Setting the Project Folder

- Select **Tools>Project Folder.** In the Browse for Folder window, select the folder containing all your GNSS Solutions projects
- Click **OK** to enable your selection and close the dialog. This updates the Project Management main window to reflect the content of the newly selected folder. Obviously if you selected the wrong folder, no workspace or project will be listed.

Backing up a Project or Workspace

Project Management can save any project or workspace as a single file (SAR file). Generating SAR backup files is the best way to archive your projects. If you back up a workspace, then the SAR file will include all the projects grouped in that workspace.

- Click on the item you want to back up
- Right-click and select **Backup**
- Enter a name for the SAR file (default: project or workspace name) and choose the folder where to save that file
- Click **Save** to create the SAR file and save it to the specified folder.

Restoring a Project or Workspace

You can restore an archived project using Project Management. Once restored, the project appears in the project folder with all its files and folders.

- Select **Tools>Restore**
- Browse your disk to find the folder containing the SAR file you want to restore
- Once you have found it, select the SAR file name and click **Open**. As a result, the Project Management main window is updated to reflect the Restore operation you have just performed. The restored item will appear either in the right or left part of the window depending on whether it's a project or a workspace respectively.

  If you restore a project on another PC that uses different user language settings, the Project Settings dialog will first open asking you to set the time zone and also to confirm the coordinate system used in the project. A "~1" suffix will appear in the system name but you can safely reselect the standard system name, i.e the name without the "~1".

Deleting a Project or Workspace

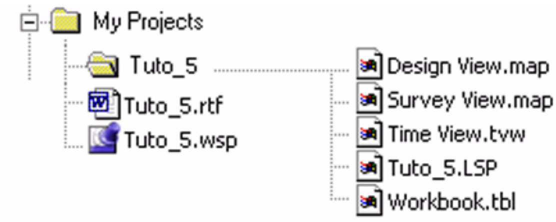
- Click on the item you want to delete
- Right-click and select **Delete**
- In the warning dialog that shows up, click **Yes** to confirm the deletion. All the files and folders pertaining to this project or workspace are tehn removed from the project folder.

  When there is only one project in a workspace, deleting either the workspace or the project will cause both the workspace and the project to be deleted.

Project Architecture

When creating a project, a new folder named **<project_name>** as well as two files are created in the **MyProjects** folder. A number of files are created in the new folder that correspond to the Time View, the Survey View, the Design View and the project database. (The Design view is visible in the open project only after the CAD function has been enabled in GNSS Solutions.) The two files created in the **MyProjects** folder define the workspace including the project.

Below is an example of what a project (in a new workspace) looks like just after creating it:



The following files will be added into the <project_name> folder as you work on your projects:

- Survey reports (RTF files)

And if you ask for a copy of these into the project folder when importing them into the project:

- Raw data files (d*.*, b*.*, e*.* files)
- Vector or/and raster maps (SHP, MIF DXF, TIF, JPG, etc.)

According to the terminology introduced in the *Advanced functions* of GNSS Solutions, when the Data Management function is valid, the types of files stored in the project folder are the following, depending on their extensions:

- *.map: map documents
- *.tvw: time view documents
- *.LSP: Land survey project database
- *.tbl: table documents
- *.rtf: RTF file containing the text displayed in the Output pane for the project (messages, processing reports, etc.)
- *.sws: file containing the current settings of GNSS Solutions main window for this workspace

  +
- *.gph: graph documents. ❑

Appendix J: Post-Adjustment Analysis

General

A least-squares adjustment of survey observations is one of the most important steps in a GPS survey. Properly used, a least-squares adjustment helps isolate blunders in the observations being adjusted and improves the accuracy and reliability of the point positions being determined. The mathematics and statistics involved in performing and analyzing a least-squares adjustment is somewhat complex but the basic concepts of the task accomplished by an adjustment are straight forward.

The primary components of a least-squares adjustment are the survey observations (angles, distances, elevation differences, and, in this case, GNSS vectors) and the uncertainties (confidence) associated with these observations. Due to measurement limitations of the surveying instruments and the influence of the instrument operators, these observations include some level of error. These errors cause loops not to close perfectly and result in the ability to compute different positions for the same point in the network based on which observations were used to compute the position.

The ultimate goal of a least-squares adjustment is to produce a set of observations where all loops close perfectly and only one position can be computed for any point in the network. In order to accomplish this task, the observations going into the adjustment must be changed slightly, i.e. adjusted. Of course, you do not want the observations to be changed much since this is what was physically observed in the field, but the observations do contain some level of error. Any error associated with an observation is predictable because of the measurement accuracy of the survey instruments used. So, do not be concerned that the observations are adjusted as long as the amount of adjustment to any given observation is not significantly greater than the expected error in the observation.

These are the fundamental guidelines to a least-squares adjustment. A successful adjustment is one where observations are changed as little as possible, and the amount of change (adjustment) to any observation is within expected levels, i.e. about the same magnitude as the uncertainty in the observation.

Unfortunately, there are a number of obstacles that can stand in the way of producing a successful adjustment. Primary on this list are blunders, errors in the observations due to equipment malfunction or operator error. Examples are an incorrectly measured instrument height, an instrument not properly centered over the survey mark, insufficient data to produce a high quality GPS vector, assigning the wrong Site ID to a point, etc. The list is long. Fortunately, tools exist to assist in overcoming these obstacles. These adjustment analysis tools have been incorporated into the adjustment module of GNSS Solutions.

After discussion of the available analysis tools, there is a section describing the process of analyzing an adjustment. From start to finish, each step of the analysis process is listed showing the sequence of when and how to use the analysis tools.

Before proceeding, there are few things you must remember when analyzing an adjustment with this tool set:

1. Many of the analysis tools are statistically based. These statistically based tools utilize the vector uncertainties (error estimates) as the basis for their testing. It is critical the observation uncertainties are realistic for the statistically based tools to function properly. Unrealistic uncertainties will cause the analysis tools to function unpredictably and, in the worst case, may make a bad adjustment look good.

   The vector-processing module is responsible for assigning uncertainties to the processed GPS vectors. A great deal of effort has gone into insuring that realistic uncertainties are determined. Unfortunately, this is not always an easy task and at times, the uncertainties may be a little optimistic (too small) or pessimistic (too large).

Recognizing this, methods were developed to help identify when uncertainties are unrealistic and to help rectify this situation. These methods are explained in detail below.

2. Adjustment analysis tools cannot function properly without redundancy in the adjusted observations. It is impossible to detect a blunder in an observation establishing the position of a point if there is only one observation at this point. When designing a survey network, be sure to include sufficient redundancy in the observations. The best case would be to include more than one observation of each point being established. Unfortunately, this is not practical and really not necessary. Select a certain percentage of points to receive multiple observations. Thirty to fifty percent is recommended. This redundancy will significantly increase the likelihood that observation blunders will be detected by the adjustment.

   In the discussion of the analysis tools below, it is assumed that sufficient redundancy exists in the adjusted observations.
3. It is also important to remember that no analysis tool gives a definitive indication of the existence of blunders or the quality of an adjustment. No one tool should ever be solely relied upon. All tools must be used together for an effective analysis of an adjustment.
4. Blunder detection should always be performed on minimally constrained adjustments. Attempting to detect blunders in a constrained adjustment is very difficult since a detected problem can either be caused by a blunder or a error in the control position fixed in the adjustment. The first step in the adjustment process should always be a minimally constrained adjustment. Use this adjustment to detect and eliminate blunders from the data set, and determine the internal quality of the survey data. After the data set is clean of blunders and it is determined that the survey meets the relative accuracy specification, a constrained adjustment can be performed.

   In the discussion of blunder detection tools below, it is assumed that the tools are being used on a minimally constrained adjustment.

Blunder Detection Tools

The blunder detection tools are designed to assist you in detecting problems with an adjustment. The tools assist in determining if blunders exist in any of the observations used in the adjustment, or if any problems exist in the network construction that would hamper the ability for an adjustment to be performed. Each tool is presented in detail below.

❑ Network Connectivity Test

In order to properly adjust an entire data set of observations, there must be connectivity between all sections of the data set. For example, look at a survey of a pipeline that will require multiple days of work to complete. Two survey crews begin work on the project, one on the north end and one on the south end. At the end of day 1, each crew will have surveyed a number of points at each end of the project. The two data sets have no observations between them yet. These two data sets cannot be adjusted together because they are not connected.

The network connectivity test examines the data set prior to adjustment to determine if there are subsets of the data set that are not connected by observations.

❑ Variance of Unit Weight/Standard Error of Unit Weight

The Variance of Unit Weight and the Standard Error of Unit Weight (the square-root of the Variance of Unit Weight) monitor the relationship between the uncertainties assigned with the observations and the magnitude of the change required to each observation (residuals) in the adjustment.

Changes to the observations should be small and should not be significantly greater than the uncertainties associated with the observations.

The Variance of Unit Weight and Standard Error of Unit Weight gauge the magnitude of the observation changes (residuals) compared to the observation uncertainties for the entire network.

Analysis of the magnitude of the computed Variance of Unit Weight and Standard Error of Unit Weight reveals one of the following three conditions regarding the quality of the adjustment:

1. A computed value close to 1 is an indication that the changes to the observations (residuals) are within expected levels, i.e. within the uncertainties associated with the observations. Since this is the desired outcome, a value close to 1 is normally an indication of a good adjustment.
2. A computed value significantly smaller than 1 indicates an imbalance between the observation residuals (changes) and observation uncertainties. Specifically, the observation uncertainties are too pessimistic (too large).
3. A computed value significantly larger than 1 is also an indication of an imbalance between the observation residuals (changes) and observation uncertainties. Specifically, one or two problems exist with the adjustment. Either one or more blunders exist in the observations causing the observation residuals to be much larger than the observation uncertainties, or the observation uncertainties are too optimistic (too small).

To fully comprehend the significance of a Standard Error of Unit Weight being significantly smaller or larger than 1, it is first imperative that any observation blunders that may exist in the observations be removed from the adjustment.

Later in this chapter you will find additional tools that are specifically designed to isolate blunders. With the absence of blunders in the network observations, the magnitude of the Standard Error of Unit Weight can be examined to determine its significance.

In a blunder-free adjustment, the magnitude of the Standard Error of Unit Weight, the magnitude of the disagreement between the uncertainties associated with the observations and what the adjustment determines should be the observation uncertainties.

For example, if the Standard Error of Unit Weight is computed to be 2 and the adjustment is blunder-free, the adjustment had determined, based on the size of the observation residuals, that the observation uncertainties should be 2 times larger than they are currently stated to be. If the computed Standard Error of Unit Weight is 0.5, then the observation uncertainties should be 2 times smaller than they are currently stated to be. Why is this important? For two reasons:

1. Many of the tools used to analyze the quality of the adjustment are statistically based. For them to work properly, the observation uncertainties going into the adjustment must be realistic, i.e. close to the real uncertainties. The Standard Error of Unit Weight computed from a blunder free adjustment gives an indication of the quality of the observation uncertainties. If the Standard Error of Unit Weight is much greater than or smaller than 1, this is an indication that the observation uncertainties are not realistic. Fortunately, GNSS Solutions automatically compensates for this problem. All post-adjustment statistics used to measure the quality of the adjustment utilize the computed value for the Standard Error of Unit Weight to automatically compensate for unrealistic uncertainties. No action on the part of the user is required.
2. A great deal of effort went into ensuring that the vector processing of GNSS Solutions assigned realistic uncertainties to the processed vectors. But since this is not yet an exact science, there are conditions that may cause the computed uncertainties to be too small or too large. In most cases, you should find that the computed Standard Error of Unit Weight falls between 1 and 3. In addition, you should find that this value is relatively consistent for similar types of surveys.

If you find that for most of your surveys, the Standard Error of Unit Weight for a blunder-free adjustment is 1.5 and today you are working on an adjustment with a Standard Error of Unit Weight of 6, there probably is something wrong with the adjustment.

❑ Chi-Square Test

The Chi-Square test is a statistical test evaluating the computed value for the Variance of Unit Weight. Its purpose is to determine if the computed value for the Variance of Unit Weight is statistically equivalent to 1. As stated earlier, a Variance of Unit Weight equal to 1 indicates a balance between observation residuals and observation uncertainties. It is very seldom that the computed value for the Variance of Unit Weight will exactly equal 1. But an exact value of 1 is not required. The Chi-Square test examines the computed value to determine if it is statistically equivalent to 1. If the test passes, the computed value is considered equivalent to 1.

Due to the difficulties in computing observation uncertainties due to the many variables involved, in many cases the Variance of Unit Weight will be larger or smaller than 1. This causes the Chi-Square test to fail. GNSS Solutions automatically compensates for observation uncertainties being too large or too small, therefore the passing or failure of the Chi-Square test has no true bearing on the quality of the adjustment.

If, by using the other blunder detection tools available, you are confident that all blunders have been removed from the adjustment and you are happy with the relative size of the observation residuals, then a failure of the Chi-Square test should not be a concern. The Chi-Square test can be made to pass, if desired, by scaling the observation uncertainties using the **Confidence scaling factor** found in the **Miscellaneous** tab of the **Project Settings** dialog. Scale the vector uncertainties by the computed Standard Error of Unit Weight.

❑ Observation Residuals

In a least-squares adjustment, small corrections are applied to the observations to obtain the best fit of all observations producing one solution for all points. The best fit is the solution that produces the least amount of corrections to the observations. These small corrections are termed residuals. Each observation will have one or more residuals. Observations have three residuals, one for each component of the vector (X,Y,Z).

The reason why observations have to be corrected at all in order to produce a good fit is due to errors in the observations. If observations contained no errors, then an adjustment would not be needed. All observations would fit together perfectly.

Two types of errors can be found in survey observations, random errors and blunders. Random errors will cause small corrections to be needed in observations in order to make them fit together properly. If only random errors exist in the data set, all residuals will likely be small. On the other hand, if large blunders exist in the data set, large residuals will likely be produced.

Examining the size of observation residuals can help in identifying blunders in the observations used in the adjustment. GNSS Solutions will display and output the residuals for all observations. These residuals should be examined in an attempt to identify blunders. If blunders are identified, they must be removed from the data set, and the adjustment rerun. If the observation containing the blunder is a critical observation of the data set, it should be examined to determine the cause of the blunder. Once repaired, the observation can be returned to the adjustment. If the observation is critical to the strength of the network and cannot be repaired, the data will need to be re-observed.

There are two main difficulties in using residuals to identify blunders in a data set.

1. Blunders, if large enough, will produce large residuals for the observation containing the blunder. But large residuals do not always indicate a blunder, in an observation. It is possible for a good observation to have large residuals. This obviously complicates the use of residuals to find blunders but this obstacle can be overcome with the understanding of why a good observation will produce large residuals. A least-squares adjustment tends to distribute the effects of blunders throughout the entire network. In other words, a blunder in one observation usually affects the residuals in other observations.

   The effect is greater on observations closer to the blunder and diminishes further out. The trick is to find the observation with the blunder among all the observations containing large residuals due to the blunder. In most cases, the observation with the largest residuals is the observation containing the blunder. Remove this observation and rerun the adjustment. If all residuals look good at this point, the blunder was identified and removed. If large residuals still exist, again remove the observation with the largest residuals and rerun the adjustment. Do this until the adjustment looks good. It is possible that some of the observations removed do not contain blunders. At this time, each observation removed should be added back to the adjustment one at a time, rerunning the adjustment each time an observation is added. If the adjustment looks good, that particular observation did not contain a blunder. If the adjustment looks bad after adding back one of the observations, the chances are very good that the observation contains a blunder. This process can be complicated even further if multiple blunders exist in the data set. But systematic removal and replacement of observations will result in identifying the blunders.

2. Throughout this section, we have talked about large residuals and their roll in identifying blunders. A natural question is 'What is a large residual?'. Unfortunately, there is no easy answer to this question. For GPS vectors, random errors in the observations increase as the length of the vector increases. Therefore, residuals will increase with baseline length. A residual of 0.10 meters on a 20-kilometer line may solely be due to random errors but the same residual on a 2-kilometer line almost surely indicates a blunder. So, a residual being large or small is dependent on the GPS vector length. There are a few guidelines that can be used to help examine residuals.

   First, all vectors of similar length should have similar residuals. Second, residuals should not be much greater than the measurement accuracy of the equipment. For example, if the equipment being used is capable of making observations at an accuracy level of 0.01m + 2ppm, the residuals for an observations should not be much greater than this capability. An accuracy specification of 0.01m + 2ppm allows for an error of 0.03m on a 10 kilometer baseline. A residual 2-3 times larger than this allowable error is suspect and should be examined closely for the possible presence of a blunder.

   Sometimes the size of a residual will be border line as to whether or not a blunder exists. If this is the case, the observation should be inspected closely to see if the cause of the blunder can be determined. If not, it is a judgement call as to whether or not the observation should be removed. If the observation is not critical to the strength of the network, it can be removed without impact. If the observation is needed but does not seem to have an adverse affect on the accuracy of the adjusted points, it can be left in.

❑ Tau Test

Examining residuals is a good indicator of the quality of individual observations. As stated earlier, the expected value of residuals are predictable since they are expected to follow a normal distribution.

The Tau test utilizes this predictability to automatically test the residuals of an observation to determine if the residuals could represent an observation containing a blunder. The Tau test utilizes the normalized residuals for an observation to determine if statistically the residual is within expected limits. A threshold value is computed to test each normalized residual against. Each normalized residual is tested with two possible outcomes:

- The Tau test passes indicating that the magnitude of the normalized residual is not greater than the expected limit for the residual. This is usually a good indication that the observation is free of blunders.
- The Tau test fails indicating that the magnitude of the normalized residual is greater than expected. The observation failing the test should be checked for blunders.

The tau test is automatically performed by the adjustment module of GNSS Solutions. Each residual is tested and the outcome of the test is presented in a check button along with the residuals for each observation.

It is important to understand, that if a residual does not pass a statistical test, it does not mean that there is a blunder in that observation. The observation is merely flagged so that it can be examined and a decision about its retention or rejection can be made. Blind rejection is never recommended. A blunder in one observation usually affects the residuals in other observations. Therefore, the tests will often flag other observations in addition to the ones containing blunders. If one or more observations are flagged, the search begins to determine if there is a blunder.

In summary, the Tau test examines observation residuals in an attempt to locate observations that may contain blunders. Each residual is tested to determine if it passes or fails the test.

- If a residual passes the Tau test, this is a good indicator that the observation does not contain blunders.
- If the residual fails the Tau test, the observation should be closely examined to determine if it contains a blunder.
- Remember that if a residual fails the Tau test, this is not a certain indicator that a blunder exists. Simply removing observations that have failed the Tau test is not recommended. These observations must be examined carefully to determine if a blunder exists.

❑ Loop Closure Analysis

In a well designed survey network, a number of closed loops, generated by GPS vectors, will exist. If all observations contained zero error, performing loop closures with various vectors throughout the network would result in loops with zero misclosure. Since in the real world, absolutely perfect survey observations are impossible, loops will generate some level of misclosure. Misclosures due to random errors in the observations should be of predictable magnitude, i.e. a magnitude similar to the measurement accuracy of the instrument used.

Misclosures due to blunders are unpredictable in magnitude, ranging in size based on the size of the blunder. Due to this, loop closures can be an effective method to isolate blunders in the data set.

When a large blunder or multiple blunders exist in a data set, it is sometimes difficult to find the blunder(s) from analysis of the adjustment output. This is due to the tendency of least-squares adjustments to distribute the error from these blunders throughout the survey network. In such cases, loop closures can be an effective tool to assist in isolating the blunders. By performing multiple loop closures in the area where a blunder(s) is suspected to exist, the vector(s) causing the blunder(s) can normally be isolated. Once the problem vector(s) is isolated, it can be examined and repaired or removed.

GNSS Solutions supplies the tools for you to perform a loop closure analysis of the survey network to assist in isolating blunders. By selecting vectors, you can create multiple loops throughout the network. The results of each loop closure are presented for analysis.

❑ Repeat Vector Analysis

When performing a GPS survey, it is recommended that a certain percentage of observed vectors be repeated, i.e. observed more than once. These repeat vectors can be used to analyze the repeatability of the observations, giving a clue to the overall quality of the final survey. In addition, repeat observations can be useful in identifying blunders if a problem arises with one of the repeated observations.

GNSS Solutions automatically performs an analysis of all repeat vectors in the network. All repeat vectors are compared to each other and differences in the observations are presented for analysis. In addition, the resulting differences between repeat observations are compared to the user-defined accuracy specification.

- If the difference between the repeat observations of a vector is smaller than the allowable error computed from the accuracy specification, the repeat vectors pass the QA test. This is normally a good indication that no blunder exists in the vectors, and that the vectors are of sufficient quality to produce a network that will meet the desired accuracy.
- If the difference between the repeat observations of a vector is larger than the allowable error computed from the accuracy specification, the repeat vectors are flagged as having failed the QA analysis test. Any repeat observations that fail the test should be examined closely to determine if a blunder exists.

❑ Control Tie Analysis

For many surveys, there is a requirement to tie the survey into a local, regional, or national control network. Many times, the exact control points to be used for this purpose will be specified. To meet this requirement, these control points will need to be held fixed in the final constrained adjustment, therefore computing positions for the new survey points in relation to the specified control points.

In addition to the requirement for tying into a control network, most surveys will also have an accuracy specification that must be met.

The control tie analysis feature automatically computes the accuracy for each control point. This is accomplished by holding one of the control points fixed in the minimally constrained adjustment and comparing the adjusted position to the known control position. The difference between the positions is computed and presented. A test then compares the user-entered accuracy specification to the computed accuracy for each control point (**Maximum acceptable control error** parameter in **Project Settings>Miscellaneous** tab.

- If the QA test passes, the computed accuracy of the tested control point meets the accuracy specification. This is an indication that the control point can be fixed in the over-constrained adjustment.
- If QA test fails, the computed accuracy does not meet the accuracy specification. Holding this control point fixed in an adjustment will cause a degradation of the network accuracy below the required accuracy specification. In such a case, the control point should be examined in detail to determine if a blunder occurred during entry of the control values. If no blunder is found, a decision must be made to determine if this point should be held fixed in the final constrained adjustment, i.e., do not hold the problem control point fixed in the final adjustment, or hold it fixed despite its accuracy. This is normally a decision made by the final recipient of the adjusted network, i.e. the client. ❑

Appendix K: Miscellaneous

List of Shortcuts

Function Key or Key Combination	Action
F1	Opens User's Guide
F2	Launches Mission Planning utility
F3	Downloads raw data from receiver or data card
F4	Imports raw data from files on disk
F5	Processes all baselines
F6	Processes unprocessed baselines
F7	Adjusts network
F8	Exports geo data to file
F9	Generates report

Alt+F5	Refreshes view (time, map, graph, collections, documents)
Ctrl+F6	Switches view
Ctrl+F4	Closes view
Alt+F4	Quits application

Mouse wheel	Pans/Scrolls vertically (map view, workbook)
Shift+Mouse wheel	Pans/Scrolls horizontally (map view, time view, workbook)
Ctrl+Mouse wheel	Zooms in/out (map view, time view)

Ctrl+P	Prints active view
Ctrl+N	Creates new project
Ctrl+A	Selects All (text, points, etc.)
Ctrl+C or Ctrl+Ins	Copies text, map view, etc.
Ctrl+X or Shift+Del	Cuts text (reports)
Ctrl+V or Shift+Ins	Pastes text, map view, etc.
Crtl+Z or Alt+Backspace	Undoes text (report)
Ctrl+N	Creates a new project or document

Function Key or Key Combination	Action
Ctrl+P	Prints document
Ctrl+S	Saves report
+	Zooms in x2 (map view, time view)
-	Zooms out /2 (map view, time view)
Alt+0	Shows/hides Command pane/workspace
Alt+1	Shows/hides output pane

Filter Codes in Legends of Map Documents

(Reminder: Data Management feature must be active in **Tools>Preferences**)
The table below summarizes all the filter codes GNSS Solutions can display on the Data tab of any Layer Properties dialog box after you have created a filter for the layer, based on a text string (Example: Filter on the “Control” parameter which should be equal to “Vertical Control (1D)”).

Filter on:	Code	Meaning
Type	0	Control Point
	5	Reference Point
	10	Logged Point
	15	Target Point
	20	Intermediate Point
Control	0	No Control
	1	Vertical Control (1D)
	2	Horizontal Control (2D)
	3	Horizontal & Vertical Control (3D)

Status	0	Unsurveyed
	10	Estimated
	20	Offset (Linear) (6502)
	21	Offset (Lateral) (6502)
	22	Offset (Intersection) (6502)
	23	Offset
	30	RTK (dynamic)
	31	RTK (static)
	40	Processed (dynamic)
	41	Processed (static)
	50	Adjusted
	60	Imported
Constraints	0	No constraints
	1	Vertical Fixed (1D)
	2	Horizontal Fixed (2D)
	3	Horizontal & Vertical Fixed (3D)
Use	0	Not used
	1	Vertical System (1D)
	2	Horizontal System (2D)
	3	Horizontal & Vertical System (3D)
Side	255	Left of P2P1
	0	N/A
	1	Right of P2P1
Source	0	Ashtech
	1	DSNP
	2	RINEX
Meas_Type	10	L1 GPS
	11	L1 GPS/GLONASS
	20	L1/L2 GPS
	21	L1/L2 GPS/GLONASS
Height_Type	0	Slant
	1	Vertical
	2	True
Mode	0	Static
	1	Dynamic
	2	Stop & Go
Orbit Type	0	Broadcast
	1	Precise SP3
	2	Precise EF18

Miscellaneous

Solutions	10	Float
	20	Partial
	30	Fixed

Other Utilities

The following utilities can be found in the Tools Menu:

Leap Seconds...: Allows manual entries of days when leap seconds occurred or will occur (you must also indicate the amount of leap seconds). GNSS Solutions will take into account these leap seconds in the processing of data collected during any of these days.

Test Time...: Opens the **Test Time** dialog box in which you can convert any GPS-formatted time (i.e. week, seconds) into local time (day, hours, minutes, seconds), taking into account the specified local time zone

GNSS antenna: Provides access to the library of GNSS antennas. In this library, you can add, edit, delete antennas. Each antenna definition includes a name, a description and the locations of its center phases with respect to features easy to locate on the antenna itself. The type of GNSS antenna used in the field is one of the properties of the observation files. With GNSS Solutions, you can change the antenna type in the observation files you import into a project. See also *Creating a New Antenna Type on page 88*. ❑

Glossary

3D: Three dimensional

A

Acquisition: The process a GPS receiver goes through to find and lock onto a GPS satellite. Once a GPS receiver has acquired 4 or more satellites, it can begin to compute positions.
Adjusted position: The final position of a survey point derived from a least squares adjustment of the measurements used to derive the position.
Adjustment: The adjustment of survey observations is the process of correcting observations to produce the best final values for the unknowns. An adjustment cannot be performed unless the set of observations being adjusted contains redundancy. The adjustment process also assists in finding and eliminating blunders in observations, and produces statistical uncertainties that can be used to estimate the final precision of the survey performed.
Almanac: Data transmitted by a GPS satellite which includes orbit information on all the satellites, clock correction, and atmospheric delay parameters. These data are used to facilitate rapid satellite acquisition. The orbit information is a subset of the ephemeris data with reduced accuracy.
Ambiguity: The unknown integer number of cycles of the reconstructed carrier phase contained in an unbroken set of data from a single satellite collected by a single receiver. Also known as integer ambiguity and integer bias.
ARP: Antenna Reference Point (GNSS antenna specification
ASCII: American Standard Code for Information Interchange. A set of characters (letters, numbers, symbols) used to display and transfer digital data in standard English format.
Autonomous position: Also known as a point, position or raw position. The position derived from a single receiver without using any differential correction. This is the least accurate method of positioning.

B

Baseline: The three-dimensional vector distance between a pair of stations for which simultaneous GPS data has been collected and processed with differential techniques. The most accurate GPS result.
Base Station: In differential positioning, the end of the baseline that is assumed known and its position fixed. Used as the basis for differential correction of unknown points.
Blunder: A mistake or error caused by confusion, carelessness, or ignorance, including, but not limited to: transposing numbers when writing down the HI or reading the HI incorrectly, occupying the wrong point.
Blunder detection: A method, or series of methods, which automatically detect blunders.

C

C/A code: The Coarse/Acquisition (or Clear/Acquisition) code modulated onto the GPS LI signal. This code is a sequence of 1023 pseudorandom binary biphase modulations on the GPS carrier at a chipping rate of 1.023 MHz, thus having a code repetition period of one millisecond. This code was selected to provide good acquisition properties.
Carrier frequency: The hardware in a receiver that allows the receiver to detect, lock-on, and continuously track the signal from a single satellite. The more receiver channels available, the greater number of satellite signals a receiver can simultaneously lock-on and track.
Carrier phase: The phase of either the L1 or L2 carrier of a GPS signal, measured by a receiver while locked-onto the signal (also known as integrated Doppler).
Cartesian coordinates: Values representing the location of a point in a plane in relation to three mutually perpendicular coordinate axes which intersect at a common point or origin. The point is located by measuring its distance from each axis along a plane parallel to the axis.
Centroid: The point whose coordinates are the average values of the coordinate of all points in the area of interest. Commonly used in transformations between two coordinate systems. Rather than computing transformation parameters around the origin of the base coordinate system, parameters are computed around a centroid. The coordinates of points can be large numbers and the mathematics involved in transformations can cause numbers to reach the limit of a computer's ability to properly store them. By using a centroid, point coordinates are reduced to a manageable size, avoiding this problem.
Channel: The hardware in a receiver that allows the receiver to detect, lock-on and continuously track the signal from a single satellite. The more receiver channels available, the greater number of satellite signals a receiver can simultaneously lock-on and track.
Code phase: Term used in reference to C/A or P-code data.
Confidence level: The goal of any measurement is to find the true value. Since all measurements contain error, the true value is never observed. In order to qualify measurements, an error estimate is statistically derived for each measurement. An error estimate has a confidence level associated with it which gives the probability that the true value of a measurement falls within the range generated by subtracting and adding the error estimate to the measured value. For example, if a measurement of 50.5 meters has an error estimate of 0.1 meters at the 95% confidence level, then there is a 95% probability that the true value is between 50.4 – 50.6 meters.
Connectivity: A test performed during a network adjustment to see if all the points in the active project are linked together by measurements. If that is the case, the project passes the connectivity test. Otherwise the test fails, which means that the project contains two or more independent point networks instead of a single one.
Constellation: The collection of orbiting GPS satellites. The GPS constellation consists of 24 satellites in 12-hour circular orbits at an altitude of 20,200 kilometers. In the nominal constellation, four satellites are spaced in each of six orbital planes. The constellation design was selected to provoke a very high proba-

bility of satellite coverage even in the event of satellite outages.

Constraints: A limitation placed on a position in an adjustment. An unknown may have a constraint that does not allow its value to be adjusted. If one of the survey points contained in the data is a control point, it's coordinates should not be adjusted since they are already known. In order to stop the adjustment from computing new coordinates for this control point, the coordinates are constrained or fixed to their known values.

Control tie: When performing a survey where the newly established network of points must be tied to a local, regional, or national network, control points from this network must be incorporated into the survey. The goal is to constrain the known coordinates of these control points in the adjustment in order to determine the position of the new points in reference to the control network. If for some reason the coordinates for one of the control points is incorrect (blunder in entry or disturbed monument), the adjustment will be distorted by constraining this point. To avoid this, the relative accuracy of control points should be checked prior to constraining them in the adjustment. A control tie is the process used to check the relative accuracy of control points.

Cycle slip: A loss of count of carrier cycles as they are being measured by a GPS receiver. Loss of signal, ionospheric interference, obstructions, and other forms of interference cause cycle slips to occur (see carrier phase). To properly compute a vector between data collected from two GPS receivers, all cycle slips must be corrected. This task is normally performed automatically by the software.

D

Datum: See Geodetic datum

Datum bias parameters: The relationship between two datums is defined by a set of 7 transformation parameters. These parameters define how the coordinates of a point in one datum change to the coordinates of the same point in another datum. When performing a least-squares adjustment, these parameters can be estimated as part of the adjustment process. This comes into play if the control points held fixed in the adjustment are on a different datum than the observations being adjusted. Datum bias parameters is the term usually used to refer to transformation parameters estimated through a least-squares process.

Differential GPS (DGPS): A technique whereby data from a receiver at a known location is used to correct the data from a receiver at an unknown location. Differential corrections can be applied in real-time or by post-processing. Since most of the errors in GPS are common to users in a wide area, the DGPS-corrected solution is significantly more accurate than a normal autonomous solution.

Differential positioning: Determination of relative coordinates of two or more receivers which are simultaneously tracking the same satellites. Dynamic differential positioning is a real-time calibration technique achieved by sending corrections to the roving receiver from one or more reference stations. Static differential GPS involves determining baseline vectors between pairs of receivers.

Differential processing: GPS measurements can be differenced between receivers, satellites, and epochs. Although many combinations are possible, the present convention for differential processing of GPS phase measurements is to subtract differences between receivers (single difference), then between satellites (double difference), then between measurement epochs (triple difference).

A single-difference measurement between receivers is the instantaneous difference in phase of the signal from the same satellite, measured by two receivers simultaneously.

A double-difference measurement is obtained by differencing the single difference for one satellite with respect to the corresponding single difference for a chosen reference satellite.

A triple-difference measurement is the difference between a double difference at one epoch of time and the same double difference at the previous epoch of time.

Dilution of Precision (DOP): The geometry of the visible satellites is an important factor in achieving high quality results. The geometry changes with time due to the relative motion of the satellites. A measure for the geometry is the Dilution of Precision (DOP) factor. DOP is a description of the effect of satellite geometry on position and time computations. Values considered 'good' are less than three. Values greater than seven are considered poor. Thus, small DOP is associated with widely separated satellites

E

Earth-Centered Earth-Fixed (ECEF): Right-handed cartesian coordinate system where the X-axis passes through the intersection of the prime meridian (Greenwich) with the equator, the Z-axis is coincident with the mean position of the earth's rotational axis, and the Y-axis is orthogonal to both the X and Z-axes.

Easting: The distance eastward from the north-south grid line that passes through the origin of a grid system.

Eccentricity: The ratio of the distance from the center of an ellipse to its focus to the semi-major axis.

EGM96: The EGM96 geoid model is a global model on a 0.25 x 0.25 degree grid. It was created from the EGM96 spherical harmonic model completed to degree and order 360.

Elevation: Height above a reference datum. The reference datum may be an ellipsoid (ellipsoidal elevation), a geoid (orthometric elevation), above mean-sea-level, or above a locally defined reference plane.

Elevation factor (sea-level factor): Elevation factor is a scale adjustment applied to distance measurements in order to reduce the distances to the ellipsoid surface. This is the first step to converting measured distances to grid distances. After the measured distance is reduced to an ellipsoidal distance, it is scaled again by the grid factor to produce a grid distance.

Elevation Mask Angle or *Minimum Elevation (Angle)*: An adjustable feature of GPS receivers that specifies that a satellite must be at least a specified number of degrees above the horizon before the signals from the satellite are to be used. Satellites at low elevation angles (five degrees or less) have lower signal strengths and are more prone to loss of lock thus causing noisy solutions.

Ellipsoid: In geodesy, unless otherwise specified, a mathematical figure formed by revolving an ellipse about its minor axis. It is often used interchangeably with spheroid. Two quantities define an ellipsoid; these are usually given as the length of the semi-major axis, a, and the flattening, f = (a - b)/a, where b is the length of the semi-minor axis. Prolate and triaxial ellipsoids are invariably described as such.

Ellipsoid Height (Elevation): The vertical distance above a reference ellipsoid for a specific point. GPS receivers compute ellipsoid heights above the WGS-84 reference ellipsoid.

Ephemeris: A list of (accurate) positions or locations of a celestial object as a function of time. Available as "broadcast ephemeris" or as post-processed "precise ephemeris"

Epoch: Time stamp for a measurement interval or data frequency, e.g., 15 seconds, 30 seconds.

Equatorial Mercator: Map projection in which meridians appear as equally spaced vertical lines, and parallels as horizontal lines drawn farther apart as latitude increases, such that the correct relationship between latitude and longitude scales at any point is maintained. The Mercator map is widely used in navigation since directions can be easily measured.

Error ellipse: All measurements contain error. The computed position of a point is never the true position because the measurements used to determine the position contain error. An error ellipse is a statistical estimate of the precision of a point position. More specifically, it is an elliptical shaped region around a point representing the area within which there is a certain probability that the true position of the point is located.

Error of closure (misclosure): Whenever closing a traverse or level loop onto the starting point, error in the observations will always produce two different positions for that point: the original position and the position computed using the measurements from the survey. For example, if the elevation of the starting point for a level run is 100.000 meters, the end elevation of the loop should be 100.000 meters if the loop ends on the starting point. But due to measurement error, the final elevation may be 100.060 meters. The difference between the two elevations is the error of closure. This error is also often referred to a misclosure

F

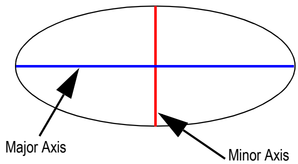
Firmware: The electronic heart of a receiver, where coded instructions relating to receiver function, and (sometimes) data processing algorithms, are embedded as integral portions of the internal circuitry.

Fixed solution: Processing of GPS vectors produces many solutions for the vector at different stages of the processing. One of the parameters being solved for during the processing is the integer ambiguity. A fixed solution is a vector solution where the integer ambiguities have been correctly determined and held fix. The fixed solution for a vector is most often the best solution. If for some reason the ambiguities could not be solved, the final solution for the vector will be a float solution.

Flattening: The ratio of the difference in lengths of the major and minor axes, respectively, of an ellipse, to the length of the major axis of the ellipse.

f = (a- b)/a = 1 -(1 - e2)1/2

a = Semi-major axis
b = Semi-minor axis
e = Eccentricity



Float solution: Processing of GPS vectors produces many solutions for the vector at different stages of the processing. One of the parameters being solved for during the processing is the integer ambiguities. A float solution is a vector solution where the integer values for the ambiguities could not be determined, therefore they are not fixed to a specific integer value (left to float as a real number.

Fully constrained adjustment: An adjustment is fully constrained when sufficient control has been constrained to allow the solving of all unknown parameters. If all seven datum bias parameters are being solved, 2 horizontal control points and 3 vertical control points are sufficient to produce a fully constrained adjustment.

G

Geocentric cartesian coordinates: x, y, and z coordinates that define the position of a point with respect to the center of the earth.

Geodetic coordinates: A coordinate system where the position of a point is defined using the components of latitude, longitude and geodetic height.

Geodetic datum: Any numerical or geometrical quantity or set of quantities that serves as a reference or base for other quantities. In surveying, two types of datums are considered: a horizontal datum, which forms the basis for the computations of horizontal positions that consider the curvature of the earth, and a vertical datum, to which elevations refer. Historically, horizontal datums were defined by an ellipsoid and the relationship between the ellipsoid and a point on the topographic surface established as the origin of datum. This relationship can be defined by six quantities, generally (but not necessarily): the geodetic latitude, longitude, and the height of the origin, the two components of the deflection of the vertical at the origin, and the geodetic azimuth of a line from the origin to some other point. GPS uses WGS-84 which, as in the newer datums, is earth-centered-earth-fixed (ECEF).

Geodetic height (ellipsoidal height): The height of a point above an ellipsoidal surface. The difference between a point's geodetic height and its orthometric height (height above ellipsoid) equals the geoidal separation.

Geoid: A gravity based surface used to best represent the physical surface of the earth. The center of the geoid coincides with the true center of the earth. Its surface is an equipotential surface, meaning that at any point the geoid is perpendicular to the direction of gravity. The geoid can be visualized by imagining that the earth were completely covered by water. This water surface is an equipotential surface since the water flows to compensate for any height difference that occurs.
Geoid height: See Geoidal separation
Geoidal separation: The height difference between the ellipsoidal height and orthometric height at any given point on the earth's surface. Worded differently, it is the separation between the geoid surface and ellipsoid surface at a given point on the earth's surface.
Geoid96: The current geoid model covering the United States, Puerto Rico, and the Virgin Islands. The GEOID96 model was computed in October, 1996 using over 1.8 million terrestrial and marine gravity values. The result is a gravimetric geoid height grid with 2' x 2' spacing in latitude and longitude. The GEOID96 model was developed to support direct conversion between NAD83 GPS ellipsoidal heights and NAVD88 orthometric heights.
Geometric Dilution of Precision (GDOP): See Dilution of Precision
Global Positioning System (GPS): Passive, satellite-based navigation system operated by the Department of Defense. It's primary mission is to provide passive global positioning/navigation for land-, sea-, and air-based operations.
GPS consists of-
-a space segment (up to 24 NAVSTAR satellites in 6 different orbits)
-the control segment (5 monitor stations, 1 master control station and 3 upload stations) the user segment (GPS receivers)
NAVSTAR satellites carry extremely accurate atomic clocks and broadcast coherent simultaneous signals.
GPS time: The time system upon which GPS is based. GPS time is an atomic time system and is related to International Atomic Time in the following manner: International Atomic Time (IAT) = GPS + 19.000 sec
GPS week: GPS time started at Saturday/Sunday midnight, January 6, 1980. The GPS week is the number of whole weeks since GPS time zero.
Greenwich mean time (GMT): Time based on the Greenwich Meridian as a reference. In distinction from time based on a local meridian or the meridian of a time zone.
Grid coordinates: Coordinates of a point on the physical earth based on a defined two dimensional grid system. These coordinates are normally referred to as Easting and Northing.
Grid system: A grid system is a defined set of parameters that, along with a map projection, are used to convert geodetic coordinates (curved surface) to grid coordinates (flat surface).
GSD-95: GSD95 is the newest Canadian geoid model. It is a refinement to the previous model, GSD91, but continues to use the same format, grid spacing, and GRS80 reference ellipsoid (as used to define the NAD83 datum. The GSD95 model was develop to support the direct conversion between NAD83 GPS ellipsoidal heights and CVD28 orthometric heights.

H

HI: Height of Instrument
Horizontal Dilution of Precision (HDOP): See Dilution of Precision

I

Ionosphere: The layers of ionized air in the atmosphere extending from 70 kilometers to 700 kilometers and higher. Depending on frequency, the ionosphere can either block radio signals completely or change the propagation speed. GPS signals penetrate the ionosphere but are delayed. This delay induces error in the GPS measurements that can result in poor survey results. Most GPS receivers/processing software model the ionosphere to minimize its affects. Also, the effects of ionosphere can be nearly eliminated by using dual frequency receivers which can calculate the delay due to ionosphere.
Ionospheric delay: A wave propagating through the ionosphere [which is a non-homogeneous (in space and time) and dispersive medium] experiences delay. Phase delay depends on electron content and affects carrier signals. Group delay depends on dispersion in the ionosphere as well, and affects signal modulation (codes). The phase and group delay are of the same magnitude but opposite sign.
Item: A set of visual elements representing any object from a collection on a map document. Typically, an item is made up of an icon and a label assigned to the icon.
ITRF: International Terrestrial Reference Frame. A world spatial reference system co-rotating with the Earth in its diurnal motion in space. More information at http://itrf.ensg.ign.fr/.

J

Julian date: The number of days that have elapsed since 1 January 4713 B.C. in the Julian calendar. GPS time zero is defined to be midnight UTC, Saturday/ Sunday, 6 January 1980 at Greenwich. The Julian date for GPS time zero is 2,444,244.5.

K

Kinematic initialization bar: A metal attachment of fixed length (0.2 meters) used to expedite the initialization process of a kinematic survey. Two receivers are attached to the kinematic initialization bar, one over a known location. They act as a fixed baseline and allow the receivers to initialize (accurate position/ambiguity resolution) more rapidly than if the receivers were to initialize across a baseline of unknown length.
Kinematic surveying: A form of continuous differential carrier-phase surveying requiring only short periods of data observations. Operational constraints include starting from or determining a known baseline, and tracking a minimum of four satellites. One receiver is statically located at a control point, while others are moved between points to be measured.

L

L1: The primary L-band signal radiated by each NAVSTAR satellite at 1575.42 MHz. The Ll beacon is

modulated with the C/A and P codes, and with the NAV message.
L2: The secondary L-band signal radiated by each NAVSTAR satellite at 1227.60 MHz and is modulated with the P code and the NAV message.
Lambert Conformal Conic: A conformal conic map projection on which all meridians are represented by equally spaced straight lines that radiate from a common point outside the map limits, and the parallels are represented by circular arcs with this common point for a center and intersect the meridians at right angles. Smallest distortion for middle latitudes. In the United States, the Lambert Conformal Conic projection is the basis of State Plane Coordinate System (SPCS) for states with predominant east-west orientation.
Latitude: Angle generated by the intersection of the semi-major axis of the datum reference ellipsoid and the ellipsoid normal (line running perpendicular to the ellipsoid surface) at the point of interest. Latitude is one of the positional elements when defining the geodetic coordinates of a point.
Layer: 1)A set of parameters defining the graphical representation on a map document of any object from a given collection - 2) A name given to geographical objects of the same family (e.g. trees, fire hydrants, etc.).
Legend: The set of layers making up the content of a map document. Each layer defines the representation, on the map document, of any object from a given collection.
Local grid coordinates: Coordinates of a point on the physical earth, based on an arbitrarily defined two dimensional grid system. These coordinates are normally referred to as Easting and Northing.
Local grid system: A local plane coordinate system usually defined for use on a small survey project. The defining parameters for the system are usually an origin with arbitrarily determined horizontal coordinates (such as 0,0 or 1000,1000) and an arbitrary direction (boundary line or backsight to another point). The local system usually stands on it's own, with no known relationship with any other defined coordinate system. This relation may be determined though if the coordinates of a sufficient number of points can be determined in both coordinates systems between which a relationship is sought.
Longitude: The length of the arc or portion of the Earth's equator between the meridian of a given place and the prime meridian expressed in degrees west or east of the prime meridian to a maximum of 180 degrees.

M

Map projection: Any systematic method of representing the whole or a part of the curved surface of the Earth upon another surface.
Minimally constrained adjustment: When performing a least-squares adjustment on GPS data, the mathematics require that the horizontal coordinates of at least one point and the vertical coordinates of at least one point (may or may not be the same point) be held fixed (constrained) to known or arbitrarily selected values. One horizontal position and one vertical position is the minimum set of constraints. An adjustment performed holding fixed the minimum set of constraints is referred to as a minimally constrained adjustment.
Misclosure: See Error of Closure
Multipath: The reception of a satellite signal both along a direct path and along one or more reflected paths. The reflected signals are caused by reflecting surfaces near the GPS antenna. The resulting signal results in an incorrect pseudorange measurement. The classical example of multipath is the ghosting that appears on television when an airplane passes overhead.
Multipath error: A GPS positioning error resulting from the use of reflected satellite signals (multipath) in the position computation.

N

NAD27: North American Datum, 1927.
NAD83: North American Datum, 1983.
Navstar: The name of GPS satellites, built by Rockwell International, which is an acronym formed from Navigation System with Time And Ranging.
Northing: The distance northward from an east-west line that passes through the origin of a grid.

O

Object: A unit of information from a collection.
Observable: In GPS surveying, the observable is another name for the raw data being collected (observed) by the GPS receiver.
Observation: The act of recording (GPS) data at a site. An example usage of the term would be, 'The observation at point 0001 lasted 1 hour'. Observation is usually interchangeable with the term occupation.
Obstruction: Physical feature that blocks the satellite direct line of site from the point of observation. GPS signals are very weak. They can be blocked from reaching the GPS antenna by objects between the antenna and the satellites. Classic examples of obstructions are trees and buildings.
Occupation: The period of recorded data for a site. For example, a 1-hour period of data collection on a survey point is considered an occupation. Occupation is usually interchangeable with the term observation.
Orthometric elevation (orthometric height): The height of a point above the geoid. Orthometric elevation is often equated with mean-sea-level elevation.
OSU91A: A global geoid model. Technically, it is a high resolution spherical harmonic model (degree 360). The errors in the geoid defined by this model are estimated at 28 cm RMS over the oceans and 46 cm RMS over the continents. This model was developed by Richard Rapp and his colleagues at Ohio State University.

P

Partially constrained adjustment: In a partially constrained adjustment, the number of constraints applied are greater than what is required for a minimally constrained adjustment, and less than what is needed for a fully constrained adjustment. An example would be a network containing two known horizontal control points and only one vertical control point. Constraining these points would result in a partially constrained adjustment where the datum bias parameters could not fully be determined.

P-Code: The protected or precise code used on both LIE and L2 GPIs beacons. This code will be made available by the DOD only to authorized users. The P code is a very long (about 1014 bits) sequence of pseudorandom binary biphase modulations on the GPS carrier at a chipping rate of 10.23 MHz which does not repeat itself for about 38 weeks. Each satellite uses a one-week segment of this code which is unique to each GPS satellite, and is reset each week.
Phase center: The phase center of a GPS antenna is the physical location on the antenna where the raw GPS signals are observed. This is the physical location where the computed position will be determined. GPS antennas are manufactured to place the phase center as closely as possible to the physical center of the antenna housing. To determine the position of a survey marker on the ground, the GPS antenna (and thus the phase center) is centered over the marker and the HI is measured to the survey marker for use during processing.
Point positioning: See Autonomous position.
Point, Control: Surveyed point whose accurate position is already known. This known position can be set as a fixed input to the processing or simply used as comparison material to assess the quality of the survey.
Point, Control, Non-fixed: Control point whose know coordinates are only used to assess the quality of a survey.
Point, Control, Fixed: Control point whose know coordinates are used as an input to the processing. The surveyed coordinates for this point are replaced with the known coordinates. This action is called "fixing" the control point.
Point, Intermediate: Logged point of lesser interest (e.g. a point in a trajectory)
Point, Logged: Point surveyed in the field in real-time or post-processing mode
Point, Reference: A point materialized in the field whose theoretical coordinates are known in the local system and that will be surveyed for calibration purposes.
Point, Target: A point whose theoretical coordinates, known in the local system, are provided for staking-out purposes.
Polar Stereographic: Projection of points on the surface of a sphere to a plane tangent at its pole. Most common map projection used for polar areas of the earth.
Position Dilution of Precision (PDOP): See Dilution of Precision.
Post-processed position: The position of a survey point obtained from the processing of GPS raw data observed simultaneously between this point an another point of known position.
Post-processing: The reduction and processing of GPS data after the data were collected in the field. Postprocessing is usually accomplished on a computer in an office environment where appropriate software is employed to achieve optimum position solutions.
PPM: Part per million
PRN number: Satellite identification number
Process: A process describes the way a pair of observation files can be processed to form a baseline and to produce a vector.
Pseudorange: A measure of the apparent propagation time from the satellite to the receiver antenna, expressed as a distance. Pseudorange is obtained by multiplying the apparent signal-propagation time by the speed of light. Pseudorange differs from the actual range by the amount that the satellite and user clocks are offset, by propagation delays, and other errors. The apparent propagation time is determined from the time shift required to align (correlate) a replica of the GPS code generated in the receiver with the received GPS code. The time shift is the difference between the time of signal reception (measured in the receiver time frame) and the time of emission (measured in the satellite time frame).

Q

QA: Quality Assurance. GPS post-processing software often has a number of different QA tests to ensure quality data is being used.

R

Random errors: Small, unpredictable errors caused by imperfections in the surveying equipment or operator procedures.
Raster map: A bitmap file, as opposed to a vector file, providing a visual representation (an image) of a map, a photo, etc. when edited
Raw data: GPS data which has not been processed or differentially corrected.
Recording interval: The time interval between the recording of GPS raw data to the GPS receiver memory. For example, a recording interval of 10 seconds indicates that GPS raw data will be stored to the GPS receiver memory once every 10 seconds.
Reference Station: A point (site) where crustal stability, or tidal current constraints, have been determined through accurate observations, and which is then used as a standard for the comparison of simultaneous observations at one or more subordinate stations. Certain of these are known as Continuous Operating Reference Stations (CORS), and transmit reference data on a 24-hour basis. Data from these sites are available for public use and can be retrieved in one hour increments from the internet at: http://www.ngs.noaa.gov/cors/cors-data.html .
Residual: The difference between the observed value and the computed value. In a least-squares adjustment of GPS data, GPS vectors are adjusted in order to find the best fit for all vectors. The adjustment of each vector produces a residual(s) for the vector. The residual is the amount the vector was adjusted to make it fit in with all other vectors. The residual values are analyzed to determine if there is a potential problem with a vector(s) in the adjustment.
RINEX: Receiver INdependent EXchange format. A set of standard definitions and formats to promote the free exchange of GPS data and facilitate the use of data from any GPS receiver with any software package. The format includes definitions for three fundamental GPS observables: time, phase, and range. A complete description of the RINEX format is found in the Commission VIII International Coordination of Space Techniques for Geodesy and Geodynamics "GPSBULLETIN" May-June,1989.

Root-Mean-Square (RMS): A statistical measure of the scatter of computed positions about a "best fit" position solution. RMS can be applied to any random variable.
Rover: The GPS receiver that moves from site to site during a kinematics GPS survey.

S

Scale factor: A scale adjustment applied to ellipsoidal distances in order to reduce the distances to grid distances. This is the second and last step to converting measured distances to grid distances. The first step is to reduce measured distances to ellipsoidal distances by applying the elevation factor.
Seed coordinate: When processing GPS raw data collected simultaneously between two points, the processing requires that the coordinates of one of the two points be held fixed. Normally, these are the known coordinates for one of the points. These coordinates are referred to as seed coordinates.
Selective Availability (SA): A Department of Defense program to control the accuracy of pseudorange measurements, whereby the user receives a false pseudorange which is in error by a controlled amount. Differential GPS techniques can reduce these effects for local applications.
Semi-major axis: One half of the major axis of an ellipse.
Semi-minor axis: One half the minor axis of an ellipse.
Session: A group of simultaneously collected GPS raw data. For example, if 4 GPS receivers collected data simultaneously on 4 points, the entire data set is considered a session. Within a session, GPS vectors can be computed between all points.
SHMP: Slant Height Measurement Point (GNSS Antenna specification).
Singularity: A condition that causes the inverse operation of a matrix to fail. Matrix inversion is an important operation in a least-squares adjustment. If a matrix inversion cannot be performed due to a singularity, there will be no adjustment. One situation that will cause a singularity is attempting to adjust GPS vectors in a network in which parts of the network are not connected to other parts, i.e. two or more sets of points that do not have connectivity to each other.
Site: A location or survey point where GPS data is collected.
Site ID: An alphanumeric identifier for a survey point. Each survey point must have a unique site ID. Otherwise, the processing will have problems determining which point certain observations belong to.
Slant height: The distance from the survey marker to the edge of the antenna ground plane. Using the slant height and radius of the GPS antenna, the true vertical height or HI of the antenna can be determined. The HI is used in the processing to determine the location of the survey marker on the ground.
Spheroid: See ellipsoid.
Standard Error (standard deviation): The goal of any measurement is to find the true value. Since all measurements contain error, the true value is never observed. In order to qualify measurements, an error estimate is statistically derived for each measurement. A standard error estimate indicates there is a 66% probability that the true value of a measurement falls within the range generated by subtracting and adding the error estimate to the measured value. For example, if a measurement of 50.5 meters has a 95% error of 0.1 meters, then there is a 95% probability that the true value is between 50.4 – 50.6 meters. The 66% value is derived from a normal distribution. For a normally distributed variable, the standard error is the bound within which 66% of the samples of the variable fall.
Static surveying: A method of GPS surveying that involves simultaneous observations between stationary receivers. Post-processing computes the vector between points.
SV: Satellite vehicle or space vehicle.
System, Geocentric: A coordinate system based on the definition of a datum providing a horizontal system only
System, Geographic: A coordinate system based on the definition of a datum providing a horizontal and vertical system
System, Projected: A coordinate system based on the definition of a datum and a projection.

T

Tau test: The Tau test is a blunder detection QA test performed on adjusted survey measurements (GPS vectors). The test examines the size of the measurement residuals and compares it statistically to an expected distribution. If the residual is larger than expected, the observation is flagged as a potential blunder.
Time Dilution of Precision (TDOP): See Dilution of Precision.
Transverse Mercator: Mercator projection turned 90o in azimuth. The central meridian is represented by a straight line, corresponding to the line which represents the equator on the regular Mercator map projection. In the United States, the Transverse Mercator is the base used in the State Plane Coordinate System (SPCS) for states with predominant north-south extent.

U

UTC: Time as maintained by the U.S. Naval Observatory. Because of variations in the Earth's rotation, UTC is sometimes adjusted by an integer second. The accumulation of these adjustments compared to GPS time, which runs continuously, has resulted in an 11 second offset between GPS time and UTC at the start of 1996. After accounting for leap seconds and using adjustments contained in the navigation message, GPS time can be related to UTC within 20 nanoseconds or better.
UTM: Universal Transverse Mercator Map Projection. A special case of the Transverse Mercator projection. Abbreviated as the UTM Grid, it consists of 60 north-south zones, each 6 degrees wide in longitude.

V

Variance of unit weight: A statistical quality indicator of a least-squares adjusted network. The expected value of the variance of unit weight is 1. A value below 1 is an indication that the uncertainties assigned to the measurements are too optimistic. A value greater than 1 is an indication that the either the uncertainties as-

signed to the measurements are too pessimistic or that there is one or more blunders in the data set adjusted.
Vector: The spatial line, described by 3D components, between two points. In GPS surveying, a vector is the product of processing raw data collected on two points simultaneously.
Vertical Dilution of Precision (VDOP): See Dilution of Precision

W

WGS84: The datum that GPS positions and vectors are referenced to. This datum is basically equivalent to the NAD83 datum used in the United States. The difference is too small to have any impact on GPS positions and vectors.

Numerics

J

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Z

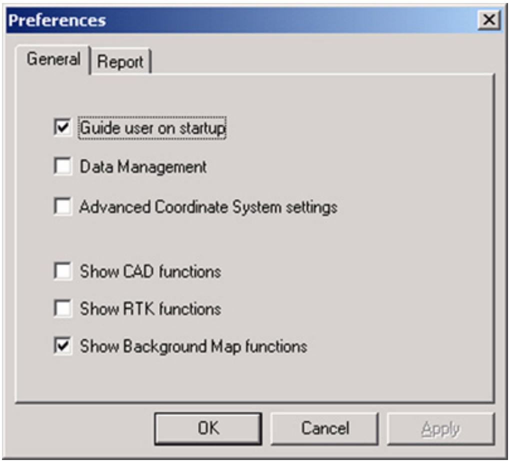
Tutorials Chapter

Supplement to the GNSS Solutions Reference Manual

Table of Contents

Important Notes

1. The first tutorial introduces notions and elements of the software that are not repeated in Tutorials #2 and #3. For this reason, reading Tutorial#1 first is highly recommended. Tutorials #2 and #3 can then be read in any order. Tutorial #4 is the continuation of Tutorial #3 and –obviously, for this reason, should be run after Tutorial #3.
2. Unless otherwise specified, GNSS Solutions is assumed to be used with only the basic options enabled. This means you should only see the following two options enabled when selecting the **Tools>Preferences** command:



3. It is also assumed that GNSS Solutions was installed with the default choices.
4. The screenshots illustrating this Tutorials chapter were obtained with a former version of GNSS Solutions. Because our processing algorithms are continuously refined for maximum accuracy, you should consider it as acceptable that slight differences may show up between the results shown on these screens and those obtained with the current version of GNSS Solutions.

Tutorial #1: Static Survey

(Average time required to complete this tutorial: 30 minutes.)

❑ Preamble

The purpose of this tutorial is to familiarize yourself with the use of GNSS Solutions in static surveys.

You will work on an example of a geodetic network survey. In this type of survey, operators customarily introduce a significant amount of redundancy in their observations for the purpose of securing their results in terms of precision.

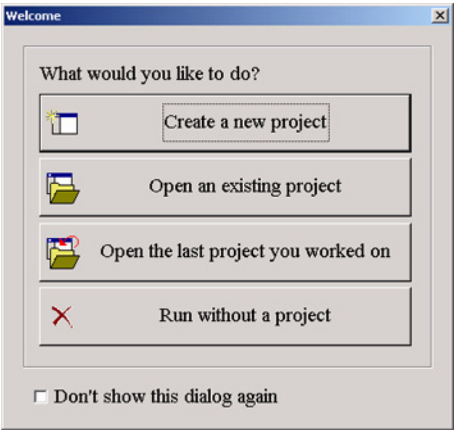
In this example, you will assume that among the points that have been surveyed in the field, two of them are 3D known points.

One of them will be closely involved in the processing: At one step in the post-processing, you will ask GNSS Solutions to use this point as a "fixed" control point, meaning that you will introduce its true coordinates in the processing, instead of letting the program use those surveyed.

The other will be used for the sole purpose of making sure the required level of accuracy has effectively been achieved in the survey.

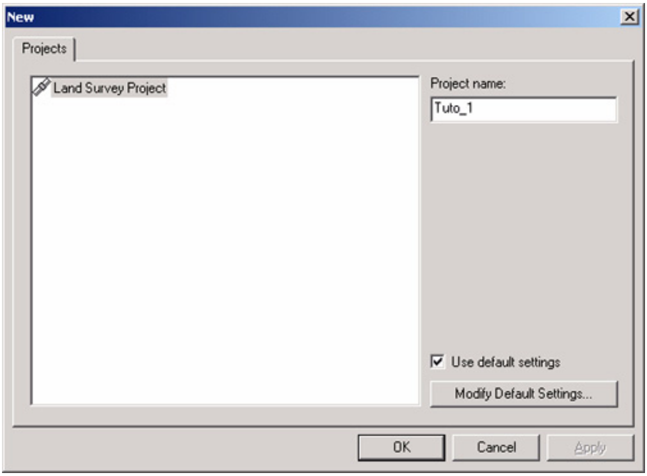
❑ Step #1: Creating a project

- To start the program, from the Windows task bar, select successively **Start, Programs, GNSS Solutions** and then **GNSS Solutions** again. The **Welcome** dialog box opens:



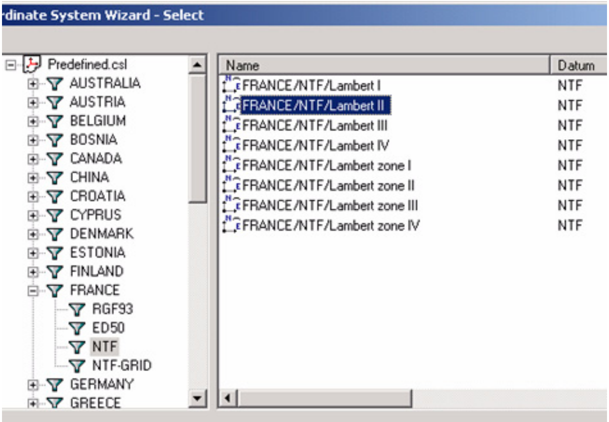
- Click on the **Create a new project** button. The **New** dialog box opens.
- In the **Project name** field, type a name for the new project.

For example, type in Tuto_1.

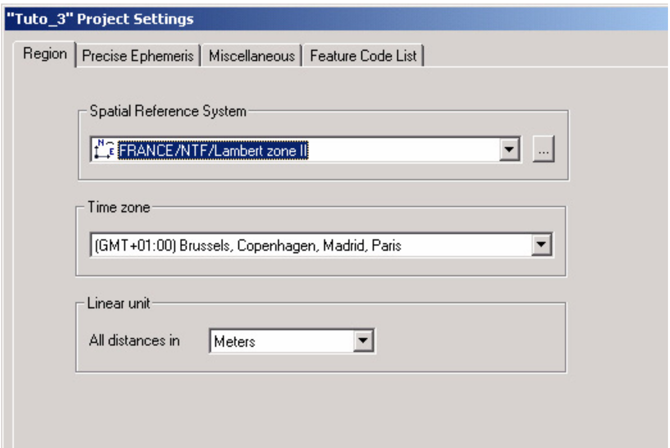


- Click on the **Modify Default Settings** button. This opens the Default Project Settings window with the **Region** tab selected by default.
- In the list attached to the **Spatial Reference System** field, select <New>. In the new dialog box that opens, the **SELECT a PREDEFINED system** option is checked by default.
- Keep this default selection and simply click on the **Next>** button.

- In the new dialog box that appears, make the following selection:



- Click **Finish**. This takes you back to the previous dialog box where the name of the chosen system now appears in the upper field
- In the **Time zone** and **Linear unit** fields underneath, make the following choices:



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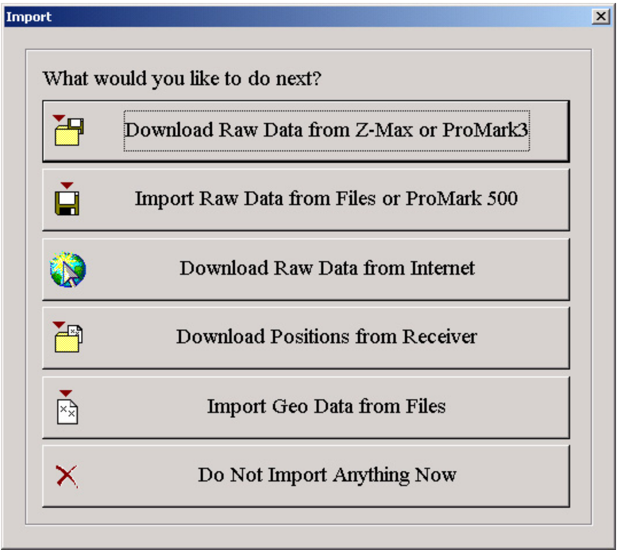
- Click on the **OK** button twice. The following dialog box is now displayed:

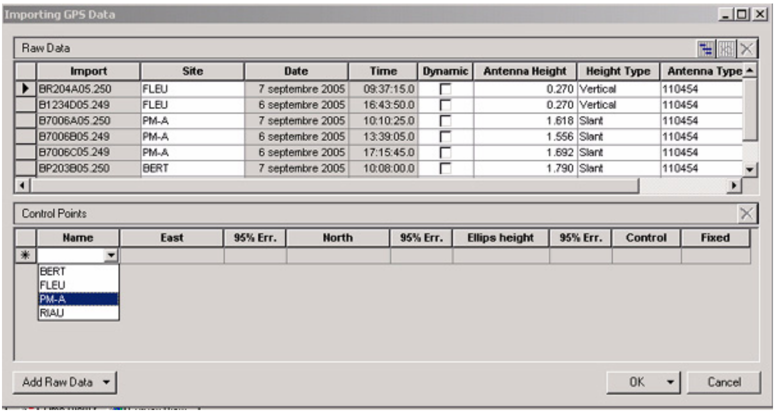


❑ Step #2: Downloading/Processing Raw Data

(This step includes defining control points and running data processing)

- Insert the GNSS Solutions CD-ROM in the computer's CD drive.
- Click on the **Import Raw Data from Files or ProMark 500** button. As a result, a new project, named "Tuto_1", opens in the GNSS Solutions main window and then the **Browse** dialog box opens.
- Using the **Look in** combo box, select the following folder on the GNSS Solutions CD-ROM: Samples\Static\.
- While holding down the Shift key (⇧), click on the first, and then on the last filename in the list to select all the observation files (GPS data files) present in the folder.

- Click the **Open** button to start importing these files into the project. A message then appears denoting data loading in progress.
  In the **Importing GPS Data** dialog box that appears afterward (see figure below), GNSS Solutions shows the properties of the raw data files you want to import (on top).
  You can also define control points. For those points you will want to fix, you will be able to enter their true coordinates (at the bottom of the dialog box).
- Click in the **Name** cell located underneath the **Control Points** header. A down arrow then appears in this cell.
- Click on this down arrow and then, from the drop-down list that appears, select the first point you want to use as a control point.
- Here select "PM-A":



- As a result, the other cells in the row show all the properties of the newly chosen control point, as deduced from one of the data files you want to import.
- Enter the true coordinates of the “PM-A” point (Easting: 313903.539; Northing: 273628.423 and Ellips Height: 13.622) and then make sure **Hor.&Ver.** is selected in the **Fixed** cell. This will transform the point into a fixed 3D control point:

Control Points

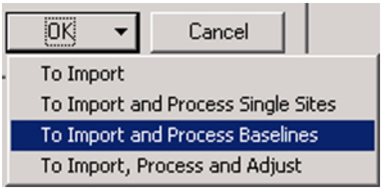
Name	East	95% Err.	North	95% Err.	Ellips height	95% Err.	Control	Fixed
PM-A	313903.539	0.000	273628.423	0.000	13.622	0.000	Hor.&Ver.	Hor.&Ver.

- In the row underneath, click in the **Name** cell and select “FLEU” as the second control point. As a result, the other cells in this row show all the properties of the newly chosen control point, as deduced from one of the data files you want to import.
- This control point should not be fixed as it is only for control. Enter its true coordinates (Easting: 309318.584; Northing: 262591.667 and Ellips Height: 32.746) and select “Blank” in the **Fixed** cell. On the other hand you need to select **Hor.&Ver.** in the **Control** cell to inform GNSS Solutions that this point will be used as a 3D control point:

Control Points

Name	East	95% Err.	North	95% Err.	Ellips height	95% Err.	Control	Fixed
PM-A	313903.539	0.000	273628.423	0.000	13.622	0.000	Hor.&Ver.	Hor.&Ver.
FLEU	309318.584	0.000	262591.667	0.000	32.746	0.000	Hor.&Ver.	

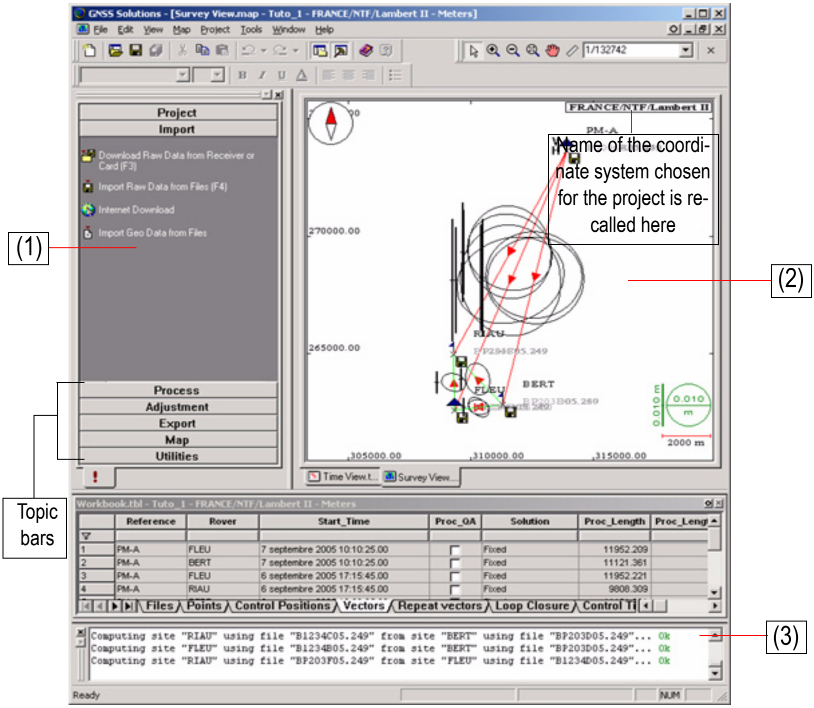
- Click on the **OK** button and select **To Import and Process Baselines**:



This enables GNSS Solutions to import the files and then automatically process the baselines using the control point “PM-A”. At the end of the processing phase, GNSS Solutions shows the results of the processing. These results are detailed in the next step.

❑ Step #3: Analyzing the project content after Download

This step gives us the opportunity to introduce the different parts that can be seen in the GNSS Solutions main window (see example below).



The **Command** pane **(1)** is designed to help you choose the right command at the right time. The available commands are organized by topic and are in fact those accessible from the menu bar but here they are shown as icons, with command names displayed after icons.

The number of topics contained in the tab is context-sensitive. To open a topic when several topics are available, click the horizontal topic bar showing the name of the topic.

ⓘ In this tutorial, you will be prompted to work with these icons rather than use the commands from the **Project** menu on the GNSS Solutions menu bar. You can however use the **Project** menu if you prefer.

The **View** pane **(2)** is a display area shared by all the views open in the project. Click on one of the tabs shown at the bottom of this pane to change the view displayed in the pane.

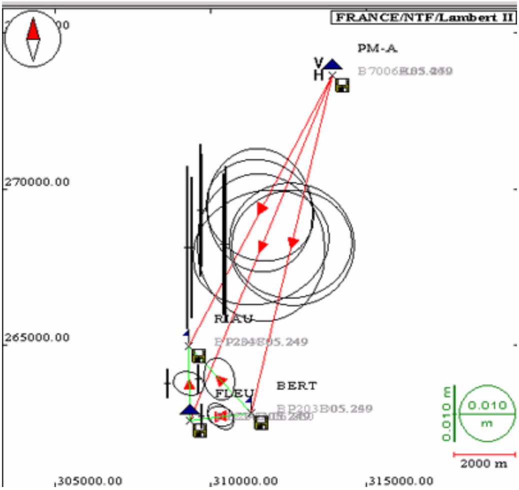
Currently, the **View** pane shows a map of the data you have just imported. Note that the displayed coordinates are in compliance with your choice of spatial reference system and the grid coordinates + map scale have been updated to match the locations of these points.

When several documents are open in a project, you choose the one you want to display in the **View** pane by simply clicking on the corresponding tab located at the bottom of the **View** pane. (These tabs will be visible only if the **View>As Worbook** option is checked –it is by default.)

Using the  button in the upper right edge of one of these documents, you can also dock this document to make it always visible. By default, the Workbook.tbl document is docked in the lower part of the **View** pane and occupies all the width of the GNSS Solutions main window (for the display of a maximum of columns at a time).

- The **Output** pane **(3)** contains message lines that attest to the different operations you run in GNSS Solutions (in the present step, data import). If you close this pane, GNSS Solutions will open it automatically when the functions you run in GNSS Solutions result in user messages sent to this pane.

Analyzing the content of the project. On the Survey View:



- The vectors determined by GNSS Solutions are shown as green/red segments depending on whether they respectively passed or failed the QA test. The size and shape of the error ellipse as well as the vertical error (a vertical segment) for each vector are represented at mid-distance along the vector. Please refer to the legend shown in the lower right on the map to assess the error ellipse and the vertical error attached to each vector.
- The location of each control point is represented by a dark blue triangle. The name of this point is displayed next to it. The letters “H” and/or “V” by the triangle icon indicate that the control point has been fixed horizontally and/or vertically.
- The location of each point where static occupation took place is represented by a flag icon on top of an upright stick. The name of the point is displayed next to it.

- Each imported file is represented by a diskette icon. The name of the file is displayed in gray characters next to the diskette icon. Each of these icons is positioned on the map based on the straight GPS solution GNSS Solutions determines from the corresponding data file.

In the Workbook table:

- Click on the **Points** tab and resize the window if necessary. This table looks like this:

Workbook.tbl - Tuto_1 - FRANCE/NTF/Lambert II - Meters

	Name	Description	East	North	Ellips height	Status	Constraints
1	FLEU	triangle-p1	309318.595	262591.638	32.703	Processed (static)	No constraints
2	PM-A	4412204-ign	313903.539	273628.423	13.622	Estimated	Horizontal & Vertical Fixe
3	BERT		311305.588	262815.656	22.499	Processed (static)	No constraints
4	RIAU		309297.147	264969.948	22.241	Processed (static)	No constraints

  This table gathers all numeric values and processing parameters resulting from the processing you have just run. Use the horizontal scroll bar to access the right-hand part of the table. Also, click on the different tabs located at the bottom of the pane to access the various categories of results. For example in this tutorial, results are displayed on the following tabs: Files, Points, Control positions, Vectors, Repeat Vectors and Control tie.

- Click on the **Vectors** tab to see the solution status of each vector. Here they have all been fixed.

Workbook.tbl - Tuto_1 - FRANCE/NTF/Lambert II - Meters

	Reference	Rover	Start_Time	Proc_QA	Solution	Proc_Length	Proc_Length_
1	PM-A	BERT	7 septembre 2005 10:10:25.00	☐	Fixed	11121.360	
2	PM-A	FLEU	7 septembre 2005 10:10:25.00	☐	Fixed	11952.207	
3	PM-A	RIAU	6 septembre 2005 17:15:45.00	☐	Fixed	9808.306	
4	PM-A	FLEU	6 septembre 2005 17:15:45.00	☐	Fixed	11952.218	
5	PM-A	RIAU	6 septembre 2005 13:40:45.00	☐	Fixed	9808.338	
6	FLEU	BERT	7 septembre 2005 10:08:00.00	☑	Fixed	1999.784	
7	FLEU	RIAU	6 septembre 2005 17:09:50.00	☑	Fixed	2378.637	

Files | Points | Control Positions | Vectors | Repeat vectors | Loop Closure | Control Ti

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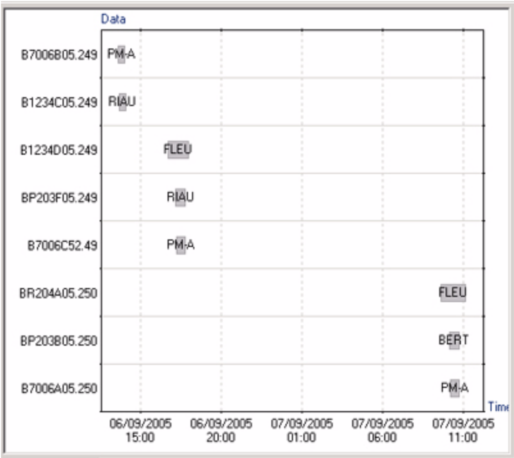
On the Time view:

- To view this diagram, click on the **Time View.tvw** tab and resize the View pane if necessary. This diagram looks like this:



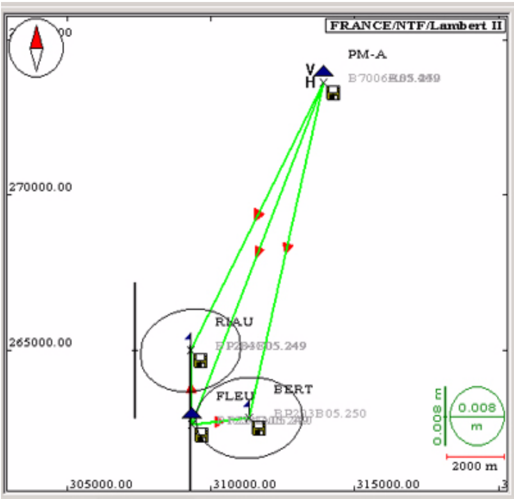
This diagram shows the imported raw data files (observation files) versus time. Inside rectangles showing the time spans of observation files are the names of the points where static occupations took place.

- The first 5 buttons on the map toolbar (located at the bottom of the GNSS Solutions main window) can be used on the Time view after clicking anywhere on this view. This means you can perform the following actions on the Time view: select, zoom in, zoom out, zoom to fit and grab.

Note: A click on *when the* **Importing GPS data** *window is open (see* *Step #2: Downloading/Processing Raw Data on page 6)* *allows you to display the Time view BEFORE importing data files.*

❑ Step #4: Adjusting the Network

- Press the **F7** key or, in the Command pane, click on the **Adjustment** topic bar and then on the **Adjust Network** icon. GNSS Solution starts adjusting the network. The adjustment results are then available on the different views. Below is what you can see on the Survey View:



- Vectors now appear as thick green lines, indicating that each of them has passed the QA test.
- Error ellipses are now provided for the surveyed points and so are centered at these points.
- If you double-click the “FLEU” point (used for control only), you will notice that the accuracy obtained for this point complies with the general level of accuracy required for the survey. This level is indicated on the **Miscellaneous** tab of the Project Settings dialog. (To open this dialog, click on the **Project** topic bar in the Command pane and then click on the **Project Settings** icon.)

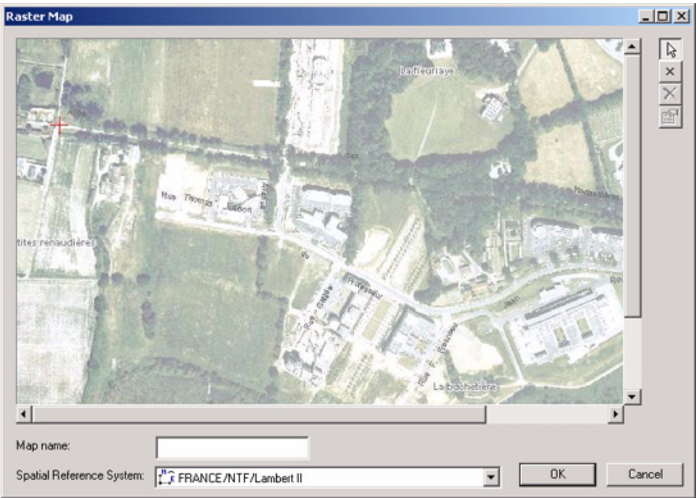
❑ Step #5: Importing a Raster Image

ⓘ In this step, you will have to use the GNSS Solutions installation CD-ROM that you have already inserted in the computer's CD drive.

1. Selecting a Raster Image for Import:

- In the Command pane, click on the **Map** topic bar and then on the **Import Raster Map** icon. This causes the **Browse** dialog box to appear.
- From the **Look in** combo box, select the following folder on the GNSS Solutions CD-ROM: ..\Samples\Maps\Raster\.

  Supported formats: BMP, JPG, JPEG2000 or non-compressed TIF.
- Select the JPG file stored in this folder and click **Open**. A new dialog box opens showing part of the map stored in the JPG file.

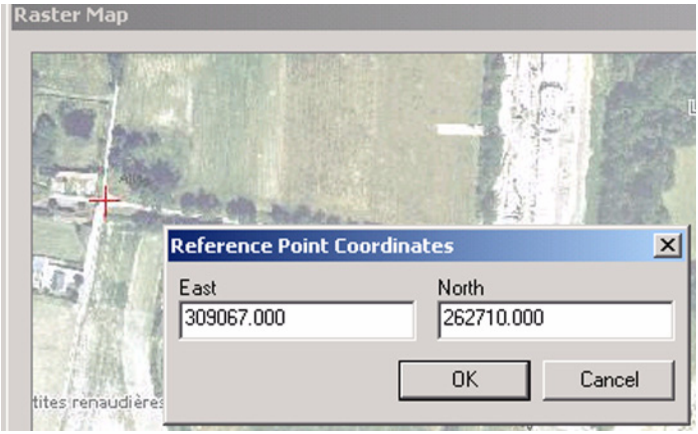


As this map is dimensionless, you need to give it geographical dimensions. To do this, you have to define at least three reference points whose coordinates are accurately known in the system used (see procedure below).

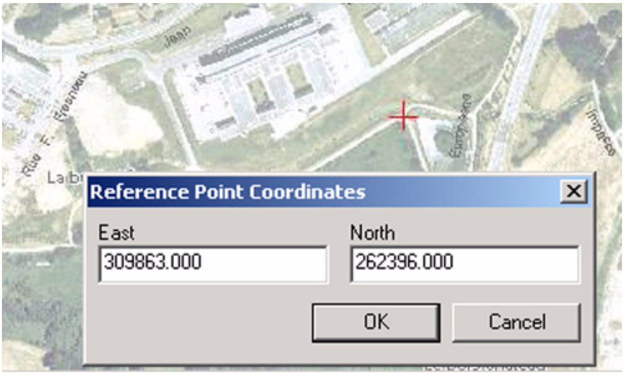
2. Sizing & Importing the Raster Image:

Refer to the numeric values contained in the two dialog boxes below to complete the present step.

- Right-click on the map and select **Add reference points**
- Click exactly on the red mark located in the upper-left corner of the map and then enter the point coordinates in the dialog box that shows up nearby. Please, enter the coordinates provided in the figure below and then click **OK**.

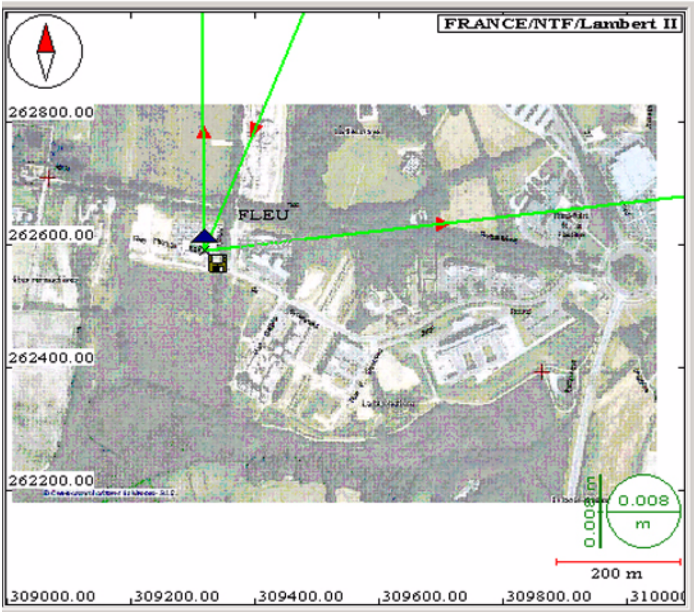


- Use the horizontal and vertical scroll bars to access the lower-right part of the map. Click exactly on the mark located in the lower-right corner of the map. As previously, enter its coordinates (refer to the figure below to know which values to enter).



- Enter the **third** and last reference point: Use the vertical scroll bar to access the upper-right part of the map. Click exactly on the mark located in the upper-right corner of the map. Enter its coordinates, which are the following: East: 309863.0000 and North 262710.000. Click **OK**.
- Then enter the name of the map in the **Map name** field (For example, type "Nantes_NE") and make sure the selected coordinate system is "FRANCE/ NTF/Lambert II".

- Click **OK** to close the dialog box. As a result, the raster map now appears on the Survey View. Zoom in repeatedly around the “FLEU” point to clearly see this map:



If you obtain something different on your screen –a distorted image for example– it means you probably made a mistake when entering the coordinates of the reference points or maybe you did not choose the right coordinate system. In either case, you have to resume the import operation and first of all delete the raster map you have incorrectly imported.

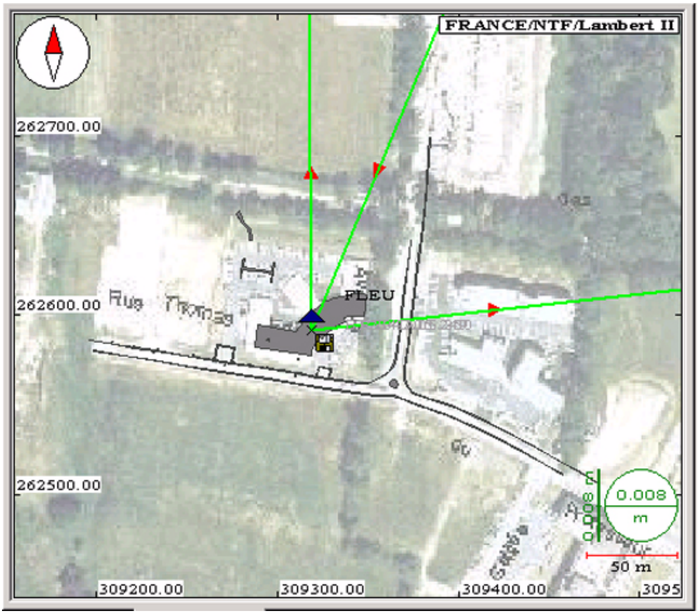
To delete the raster map:

- Right-click anywhere on the Survey View and select **Legend** to open the Map Properties dialog box
- Scroll-down the list displayed in this dialog until you see the **Nantes_NE** layer (last in the list)
- Select this layer and then click on 
- Click **OK** to close this dialog. As a result, the map disappears from both the Survey View and the project.
- Resume step#5.

❑ Step #6: Importing a Vector Layer

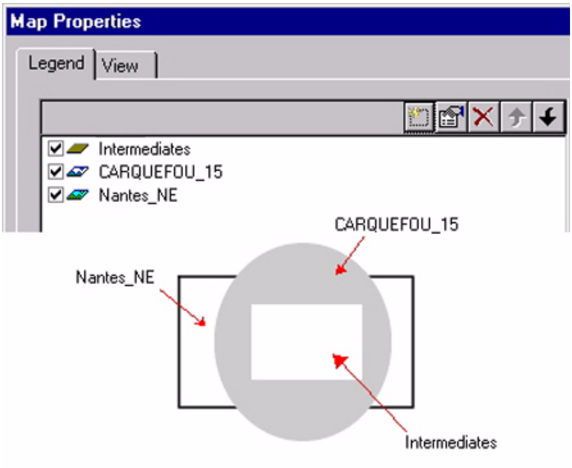
ⓘIn this step, you will have to use the GNSS Solutions installation CD-ROM that you have already inserted in the computer's CD drive.

- Click on the **Import Vector Map** button This causes the **Browse** dialog box to appear
- From the **Look in** combo box, select the following folder on the GNSS Solutions CD-ROM: ..\Samples\Maps\Vector\.
- Select the file stored in this folder and click **Open**.
  As a result, the vector layer is imported into the project.



Note that the order in which layers are listed in the **Legend** tab of the Map Properties dialog box impacts the way layers are superimposed on the map.

The mechanism is summarized in the figure below:

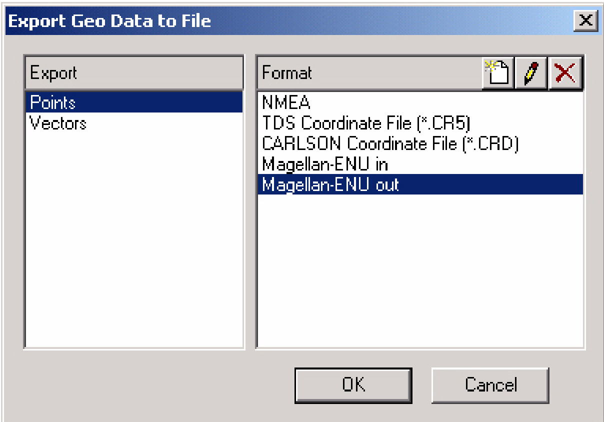


(To display the legend, right-click anywhere on the map and select **Legend**)

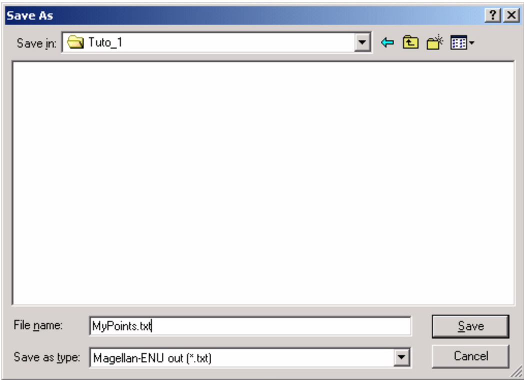
As shown above, the first layer in the list is brought to front, the last one is sent to back. Intermediate layers occupy intermediate positions between the front and the back. GNSS Solutions always places raster map layers you import at the bottom of the list as they are more liable than any other layer to mask all others.

❑ Step #7: Exporting Data to a File

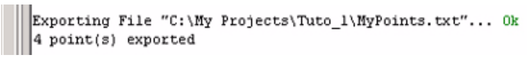
- In the workbook, click on the **Points** tab and then select all the points listed on this tab. To do this, click once in the leftmost cell in the first row and then, while holding down the Shift key (⇧), click anywhere in the last row.
- In the upper-left pane of the GNSS Solutions main window, click on the **Export** topic bar and then on **Export Geo Data to File**
- In the dialog box that appears, make the following two choices:



- Click **OK**. A new dialog box appears asking you to choose a folder where to store the export file and name this file. Select the “Tuto_1” project folder in the **Save in** field. Then, type in “MyPoints.txt” as the file name:



- Click **Save**. The end of data export is denoted by the following message in the Output pane:



❑ Step #8: Creating a Report

- Press the **F9** key or, in the Command pane, click on the **Export** topic bar and then on the **Land Survey Report** icon. This opens a new dialog box in which you can define the content of the report.
- Choose freely the items you would like to include in the report (clear those you do not want).
- Then, in the **Report name** field, enter “MyReport”.
- Click **OK.** GNSS Solutions then starts creating the report document. This document displays in the View pane as it is being created. Once GNSS Solutions has finished creating the report, a new tab mentioning the name of the report appears in the View pane.

❑ Step #9: Closing the project

- Select **File>Close**. This saves and closes the project contained in the workspace, and the workspace as well.
  End of Tutorial #1.

Tutorial #2: “Stop & Go” Survey

(Average time required to complete this tutorial: 20 minutes.)

❑ Preamble

The purpose of this tutorial is to familiarize yourself with the use of GNSS Solutions in Stop & Go surveys.

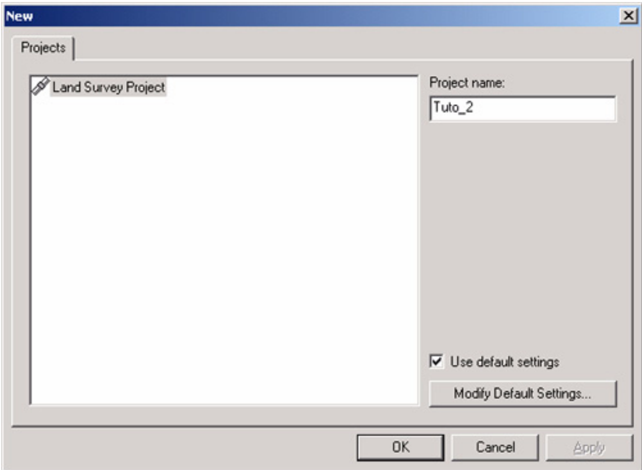
The Stop & Go survey you will be working on in this tutorial was run as follows:

- A base station was installed and operated at a known 3D point for about an hour. The raw data collected during this time at the base station has resulted in an observation file that you will import into this tutorial project.
- A rover was moved from point to point in Stop & Go mode within this period of time. Initialization took place at a known point. The raw data collected during this time by the rover has resulted in a single observation file that you will also import into this tutorial project.

It is a good practice during a Stop & Go survey to collect data at a known point. This point is visited in the same way as are all the points you need to survey. After processing the collected data in GNSS Solutions, you will be able to qualify the results of the survey using this point as a non-fixed control point. In our tutorial such a point was visited.

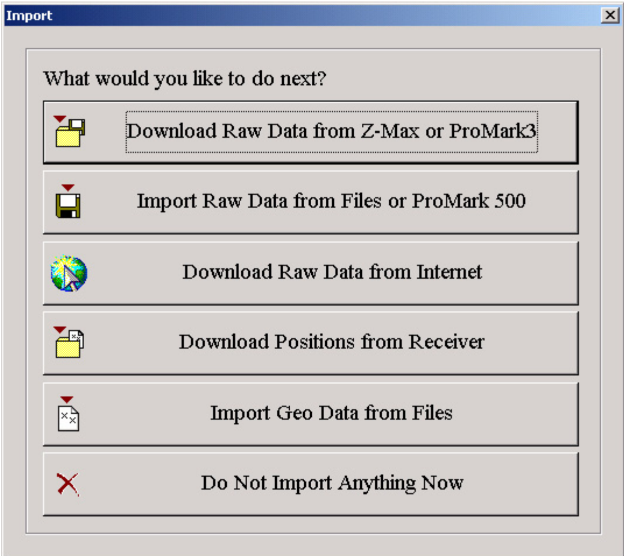
❑ Step #1: Creating a New Project

- In the Command pane, click on the **Project** topic bar and then on the **Create New Project** icon. In the **New** dialog box that opens, type in a name for the new project in the **Project name** field. For example, type in **Tuto_2**:



- Click on the **Modify Default Settings** button. In the new dialog box that appears, select **FRANCE/NTF/Lambert II** as the spatial reference system to be used in the new project. Keep the default selection in the **Time zone** field. Choose “Meters” in the **All Distances in** field.

- Click on the **OK** button twice. The following dialog box is displayed:



- Click on **Do Not Import Anything Now**. This closes the dialog box and you can now see the blank project open in the main window.

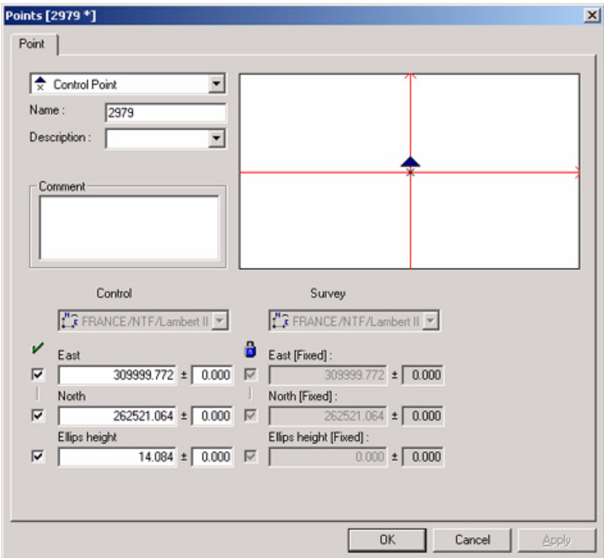
❑ Step #2: Creating the Control Point Used for Initialization

When field initialization is performed at a known point –which is the case in this example– you must define this point as a control point in the project before processing the files. Otherwise GNSS Solutions will process the files as if initialization had been performed in OTF.

For kinematic surveys that you initialized with the initializer bar or in OTF, GNSS Solutions will automatically process the files without the need for you to enter any additional information.

- Click anywhere inside the Survey View to activate the map tool bar (located at the bottom of the GNSS Solutions main window).

- On the map toolbar, click 
- Move the mouse cursor back onto the Survey View and click anywhere within this view. This opens the Point dialog box in which you can fully define the known point.
- Keep the default choice for the point type (“Control Point”) as this is exactly what we want this point to be.
- Enter the name of the point (“2979”) in the field underneath
- Enter the coordinates of “2979” in the three control coordinate fields. These coordinates are:
- Easting: 309999.772
- Northing: 262521.064
- Height: 14.084



- Click **OK** to create the point and close the dialog.
- Right-click anywhere on the Map view and select **Zoom to Fit**. The Survey View now shows this point at its true location on the map.

❑ Step #3: Downloading/Processing Raw Data

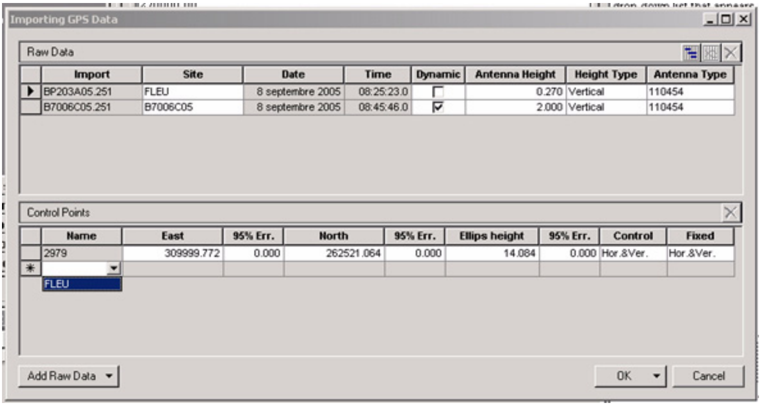
(This step includes defining the base position as a control point.)

- Insert the GNSS Solutions CD-ROM in the computer's CD drive.
- In the Command pane, click on the **Import** topic bar and then on the **Import Raw Data from Files or ProMark 500** icon. This opens the **Browse** dialog box.
- Using the **Look in** combo box, select the following folder on the GNSS Solutions CD-ROM: Samples\Stop&go\.
- While holding down the Shift key (⇧), click on the first, and then on the last filename to select all the observation files (GPS data files) present in the folder.
- Click the **Open** button to start importing these files into the project. A message then appears denoting data loading in progress.

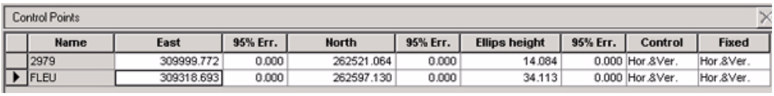
  In the **Importing GPS Data** dialog box that appears afterward (see figure below), GNSS Solutions shows the properties of the raw data files you want to import (on top).

  You can also right now define the control point and enter the true coordinates of this point (at the bottom). Note that in this dialog box, GNSS Solutions also mentions the control point already present in the project (here point "2979").
- Click in the **Name** cell located underneath the **Control Points** header. A down arrow then appears in this cell.

- Click on this down arrow and then, from the drop-down list that appears, select the point you want to use as the control point. Here you can only select “FLEU” so select now this point.



This causes the other cells in this row to show all the properties of the newly chosen control point, as deduced from one of the data files you want to import:



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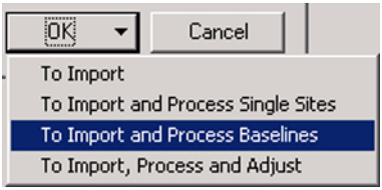
- Enter the true coordinates of the "FLEU" point (Easting: 309318.584, Northing: 262591.667, Height: 32.746) and then fix this point horizontally and vertically to transform this point into a 3D control point (select **Hor&Ver** in the **Fixed** cell):

Name	East	95% Err.	North	95% Err.	Ellips height	95% Err.	Control	Fixed
2979	309999.772	0.000	262521.064	0.000	14.084	0.000	Hor.&Ver.	Hor.&Ver.
FLEU	309318.584	0.000	262591.667	0.000	32.746	0.000	Hor.&Ver.	Hor.&Ver.

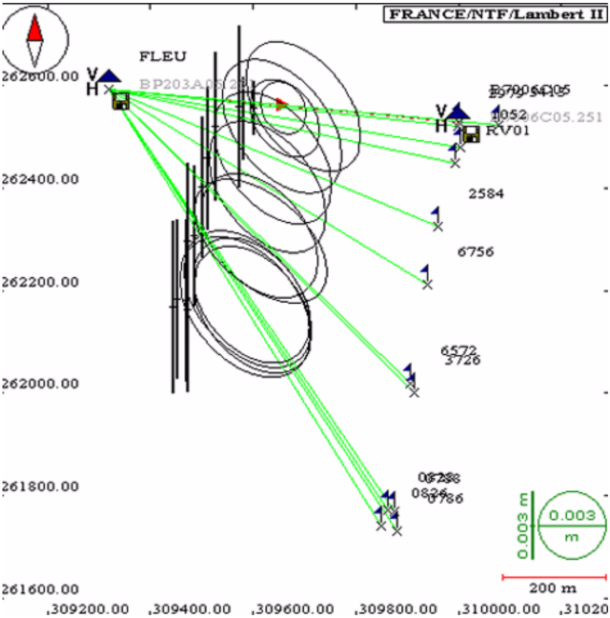
- Click on the **OK** button and then select **To Import and Process Baselines**:



This enables GNSS Solutions to import the files and then automatically process the baseline between the two points. At the end of the processing phase, GNSS Solutions shows the results of the processing. These results are detailed in the next step.

❑ Step #4: Analyzing the Results

On the Survey View:



- The two control point are each represented by a dark blue triangle. The name of this point is displayed next to it. The letters "H" and "V" by the triangle icons indicate that the control points have been fixed horizontally and vertically.

- The location of each point where static occupation took place is represented by a flag on top of an upright stick. The name of the point is displayed next to it.
- The point “B7006C05” is not a point that you surveyed but represents the location where GNSS Solutions placed the rover’s data file when you imported this file into the project (this position was determined in autonomous GPS mode using the data from the file). Do not delete this point as this would cause the corresponding observation file to be deleted as well.

In the Workbook table:

- Click on the **Points** tab and resize the window if necessary. This table looks like this:

Workbook.tbl - Tuto_2 - FRANCE/NTF/Lambert II - Meters

	Name	Description	East	North	Ellips height	Status	Constraints
1	2979	control	309999.772	262521.064	14.084	Processed (static)	Horizontal & Vertical F
2	FLEU	THALES NAV	309318.584	262591.667	32.746	Estimated	Horizontal & Vertical F
3	B7006C05	1000	310000.287	262527.047	17.483	Estimated	No constraints
4	1052	man hole	310004.216	262479.097	12.464	Processed (static)	No constraints
5	RV01	1000	309993.732	262447.993	11.332	Processed (static)	No constraints
6	2584	man hole	309959.263	262324.403	7.985	Processed (static)	No constraints
7	6756	man hole	309938.349	262212.867	7.449	Processed (static)	No constraints
8	6572	man hole	309906.995	262019.587	7.851	Processed (static)	No constraints
9	0828	man hole	309861.887	261771.549	9.796	Processed (static)	No constraints
10	0826	man hole	309848.601	261741.255	10.694	Processed (static)	No constraints
11	0786	man hole	309879.693	261731.937	10.450	Processed (static)	No constraints

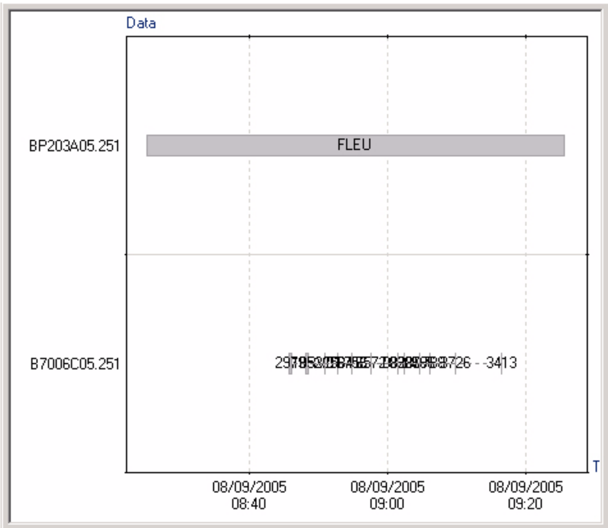
Files | Points | Control Positions | Vectors | Repeat vectors | Loop Closure | Control Ti

The Workbook table gathers all numeric values and processing parameters resulting from the processing you have just run. Use the horizontal scroll bar to access the right-hand part of the table.

Also, click on the different tabs located at the bottom of the pane to access the various categories of results. For example in this tutorial, results are displayed on the following tabs: Files, Occupations, Points, Control positions, Vectors and Control tie. A very important thing to do is to check that all vectors have a “fixed” solution status. This is the case here for all vectors.

On the Time view:

- To view this diagram, click on the **Time View** tab and resize the View pane if necessary. After appropriate zoom-in and grab operations using the relevant buttons on the map toolbar (located at the bottom of the GNSS Solutions main window), the diagram should look like this:



This diagram shows the imported raw data files (observation files) versus time. The raw data file represented on top of this diagram was recorded at the base station (control point "FLEU") and is the longest in time. It is represented as a single gray rectangle covering about 1 hour. The name of the point appears inside the rectangle.

The raw data file just underneath was recorded by the rover. Several distinct rectangles are shown for this file. Each of them represents a static occupation on a point. The name of this point appears inside the rectangle. Dotted lines between rectangles represent periods of time during which the operator walked from one point to the next one.

Note: A click on  *when the* **Importing GPS data** *window is open (see* *Step #3: Downloading/Processing Raw Data on page 30**) allows you to display the Time view BEFORE importing data files.*

❑ Step #5: Qualifying the Results

As mentioned at the beginning of this tutorial, one of the points visited during the survey is in fact a known point. Its true coordinates are:

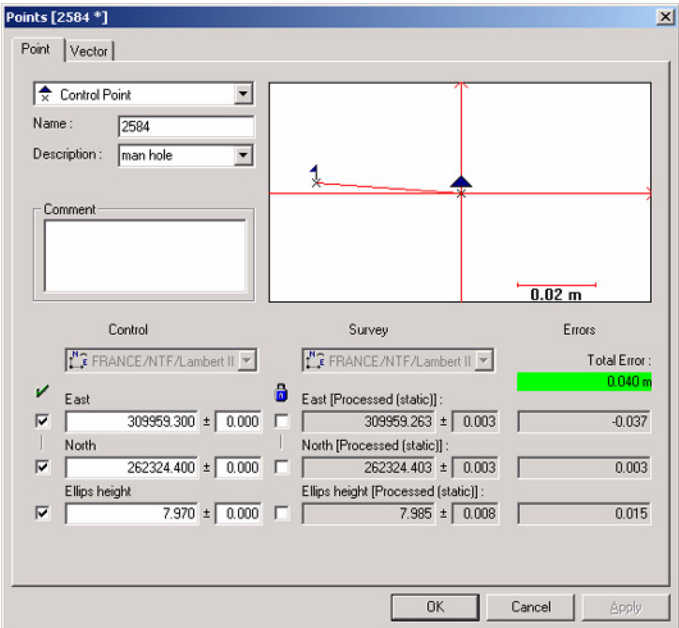
- Easting: 309959.300
- Northing: 262324.400
- Height: 7.970

This point was named "2584" by the field data collector. If you transform this point into a control point, GNSS Solutions will provide the total error between the true and surveyed locations of this point thus giving a good idea of how accurate the survey was.

- Click on the Survey View tab and then double-click the "2584" point to open its Properties window.

- On the **Point** tab, in the upper-left corner, change the point type to "Control Point"
- Now enter its true coordinates (see values given above) in the 3 fields located underneath the **Control** section (after entering the height value, click inside any other valid field to validate the height value). As a result, the dialog box now displays the total error between the surveyed and true coordinates.

  Here the error is compatible with the level of accuracy required. This level is indicated on the **Miscellaneous** tab of the Project Settings dialog. (To open this dialog, in the Command pane, click on the **Project** topic bar and then on the **Project Settings** icon.)



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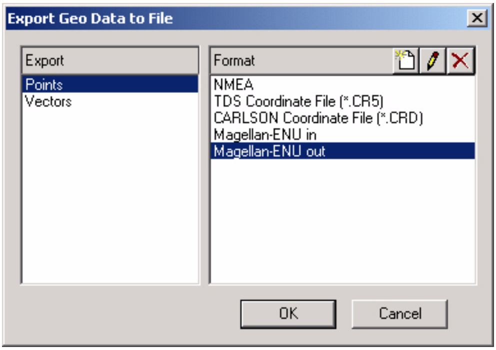
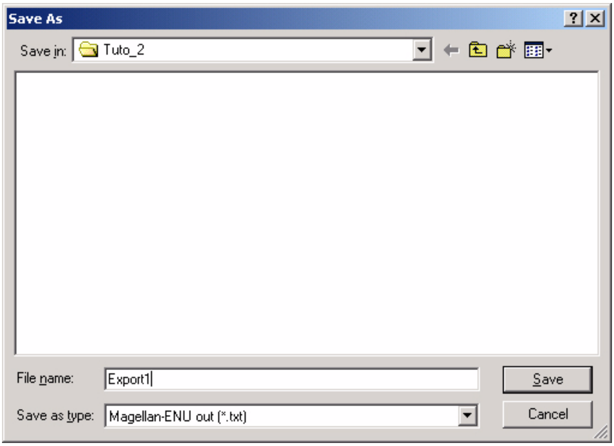
❑ Step #6: Exporting Data to a File

- Click on the **Points** tab in the workbook.
- Select the 1st to 7th points in the table. To do this, click once in the left-most cell in the first row and then, while holding down the Shift key (⇧), click anywhere in the 7th row.
- In the Command pane, click on the **Export** topic bar and then on the **Export Geo Data to File** icon.
- In the dialog box that appears, make the following two choices:

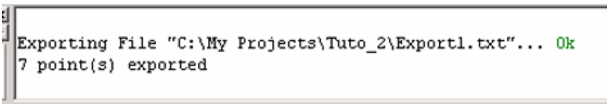


- Click **OK**. A new dialog box appears asking you to choose a folder where to store the export file and name this file. Select the “Tuto_2” project folder in the **Save in** field.

- Then, enter "Export1" in the **File name** field:



- Click **Save**. The end of data export is denoted by a message in the Output pane.



❑ Step #7: Creating a Report

- Press the **F9** key or, in the Command pane, click on the **Export** topic bar and then on the **Land Survey Report** icon. This opens a new dialog box in which you can define the content of the report.
- Choose freely the items you would like to include in the report (clear those you do not want).
- Then, in the **Report name** field, enter “MyReport”.
- Click **OK.** GNSS Solutions then starts creating the report document. This document displays in the View pane as it is being created. Once GNSS Solutions has finished creating the report, a new tab mentioning the name of the report appears in the View pane.

❑ Step #8: Closing the project

- Select **File>Close**. This saves and closes the project contained in the work-space, and the workspace as well. End of Tutorial #2.

Tutorial #3: Real-Time Survey

(Average time required to complete this tutorial: 25 minutes.)

❑ Preamble

With this tutorial, you will learn how to use GNSS Solutions before and after a real-time survey. The survey example includes staking-out and point logging operations.

In this example, the target and reference points are not created in the project, although this would be possible using the map toolbar. Instead, target and reference points are made available in the form of a text file that was especially prepared for you.

The field survey step will be bypassed, as it does not fall within the scope of this document. You will however be provided with a results file, as if you had performed the field survey by yourself, so that the post-survey steps can be run with GNSS Solutions.

In this survey example, the base station was operated on a reference point whose coordinates are accurately known in the local system used. In addition, this installation point was chosen to offer a clear view of the sky for best possible GPS reception.

After surveying a couple of points that are also accurately known in the local system, the field operator was able to perform an in-the-field calibration allowing her/him to refine the parameters of the local system used and afterwards, to survey all the other points with the same level of precision as the known points. With GNSS Solutions, you will be able to re-run this calibration at the office for safety or cross-checking purposes.

This tutorial is also valid for those of you who prefer to work with the base station operated on an unknown point.

In this case however the calibration is essential, not to say vital, as it brings about a significant leap in the precision from a few meters (due to floating base station position determined in Autonomous GPS mode) to less than one centimeter. In addition, surveyors using this method will only obtain local coordinates for their surveyed points whereas the first method would provide both WGS84 and local coordinates.

Choosing a method rather than the other then only depends on whether you need the true WGS84 coordinates for the surveyed points or not.

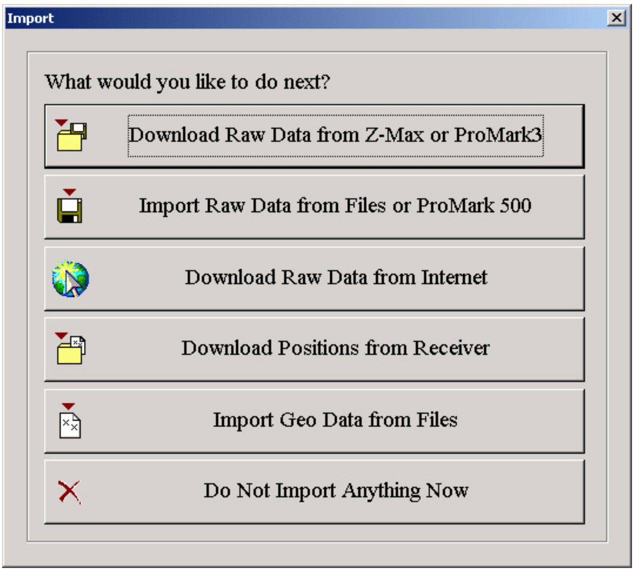
❑ Step #1: Enabling the RTK Functions

- From the menu bar, select **Tools>Preferences**.
- In the dialog that opens, check the **Show RTK functions** option
- Click **OK**.

  ⚐ *If you don't need it in your applications, do not forget to disable this option after running this tutorial.*

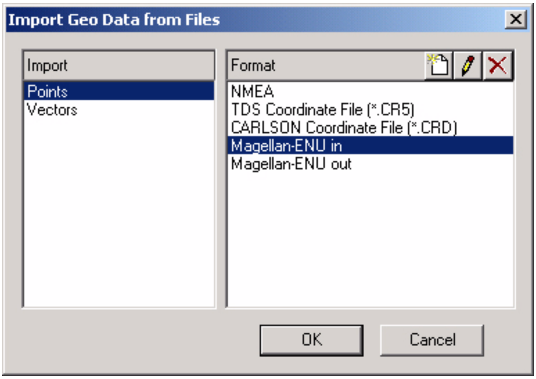
❑ Step #2: Creating a New Project

- In the Command pane, click on the **Project** topic bar and then on the **Create New Project** icon. In the **New** dialog box that opens, type in a name for the new project in the **Project name** field. For example, type in **Tuto_3**:
- Click on the **Modify Default Settings** button. In the new dialog box that appears, select **FRANCE/NTF/Lambert II** as the spatial reference system to be used in the new project. Keep the default selection in the **Time zone** field. Choose "Meters" in the **All Distances in** field.
- Click on the **OK** button twice. The following dialog is now displayed:

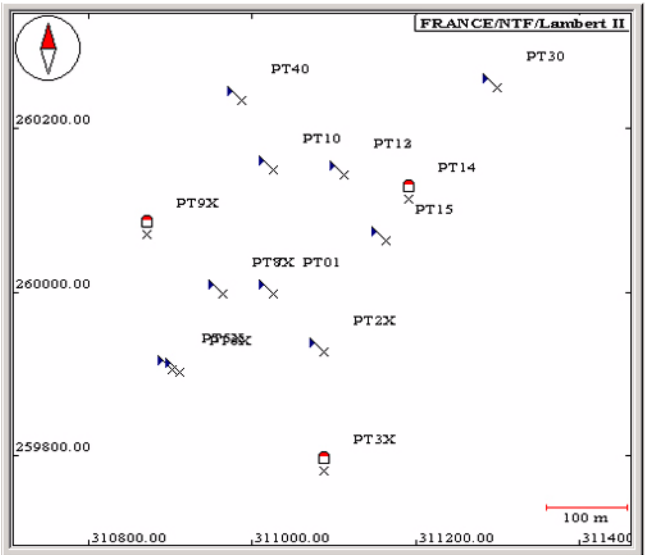


❑ Step #3: Importing Points into the Project

- Click on **Import Geo Data from Files**. As a result, a new project, named "Tuto_3", opens in the GNSS Solutions main window.
- In the dialog box that appears, make the following two choices:



- Click **OK**. The **Open** dialog box now opens.
- Insert the GNSS Solutions CD-ROM in the computer's CD drive
- Using the **Look in** combo box, select the following folder on the GNSS Solutions CD-ROM: Samples\RealTime\.
- Select the txt file stored in this folder and click **Open**. GNSS Solutions starts importing the file into the project database. A message is displayed while data import takes place. At the end of the import phase, the imported points appear in the Survey View.

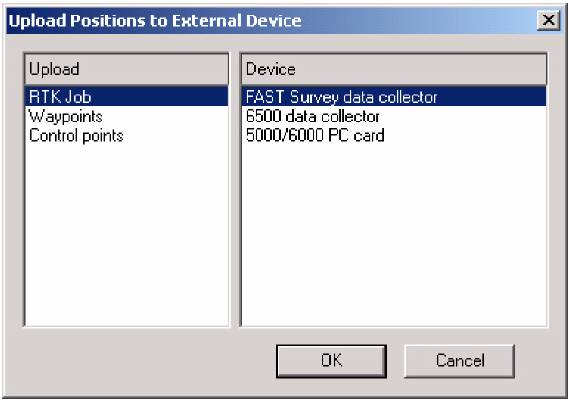


❑ Step #4: Uploading the Job to the Surveying Device

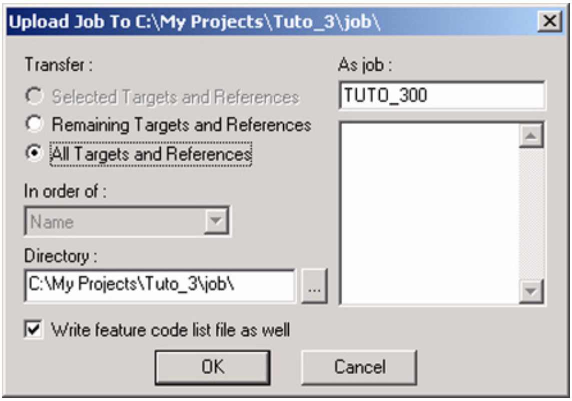
ⓘ Before running this step, connect the Z-Max data collector to your office computer via a serial line and switch it on. If you do not have a data collector available, do not worry! Just skip ahead to step #6.

- On the data collector, launch the FAST Survey software. Make sure the selected Com port is the one you are actually using. Select the **File** tab, then the **Data Transfer** function and then the **SurvCADD/Carlson Survey Transfer** function. The data collector screen should then display “File Transfer Utility... Awaiting Connection”.

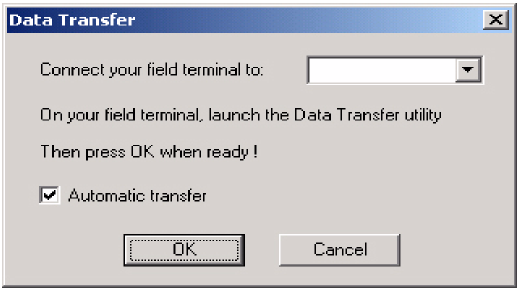
- On the GNSS Solutions side, in the Command pane, click on the **Export** topic bar and then on the **Upload Positions to External Device** icon. In the dialog box that opens, make the following choice:



- Click **OK**. Make the following selection:



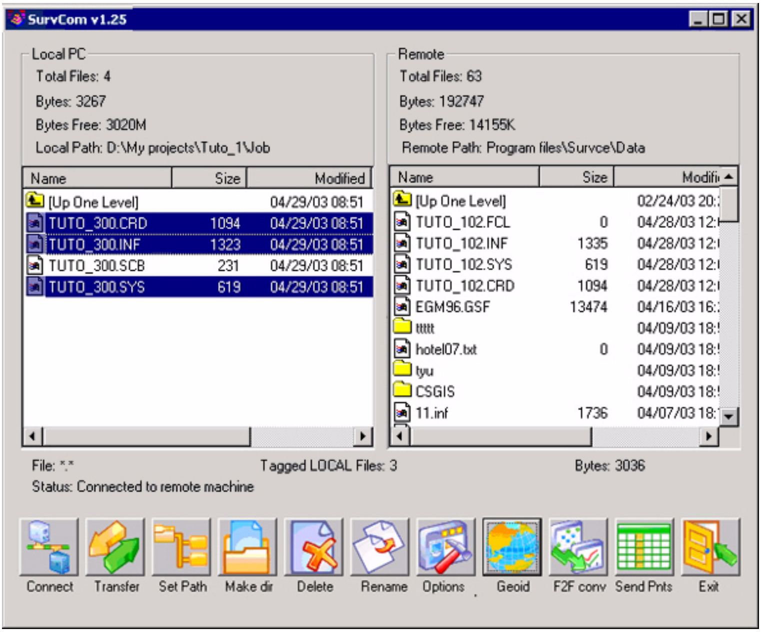
- Accept all the defaults by simply clicking **OK**. This opens the following dialog box asking you to connect and run the field terminal (which was done at the beginning of this step) and to specify the conditions of transfer (Automatic or not; Default=Automatic).



- In the combo box, select the port used (ActiveSync for a connection with a field terminal running FAST Survey) and then click **OK**. A number of messages are displayed in turn denoting transfer in progress ("Retrieving directory listing", "File transfer...% complete").

  Should GNSS Solutions fail to connect to the field terminal, please resume the above procedure in Manual Mode, i.e. clear the **Automatic transfer** *check box when GNSS Solutions displays the above dialog box. This will open the SurvCom dialog box. You will then be able to check the PC port settings (cf.* **Options** *button) and resume data transfer manually from this dialog box (cf.* **Connect** *button).*

A number of files need to be transferred for any job you wish to upload to the data collector: the CRD file, the SYS file, the INF file, the FCL file and the SCB file. When the transfer is automatic, GNSS Solutions knows which files to transfer. When the transfer is manual, you must select these files in the left-hand pane before uploading. For this tutorial, you would have to select the following files in the left-hand pane before clicking the **Transfer** *button (2nd button from the left in the lower part of the dialog box):*



❑ (Step #5: Field Survey)

Skipped. (This step does not fall within the scope of this manual.)

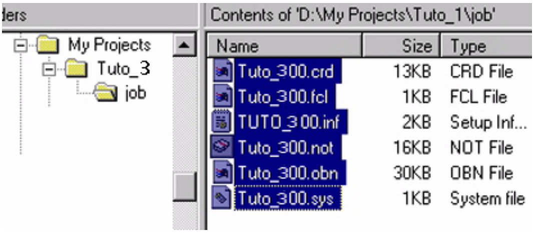
❑ Step #6: Downloading Results

ⓘ In this step, because you are just working on an example, you will be asked to copy result files from the installation CD-ROM to the job folder. Make sure the installation CD-ROM is still in the CD-ROM reader on your PC.

Remember however that in normal conditions of use, before running this step, you should connect the data collector to your office computer via a serial line, switch it on, launch the FAST Survey software, select the File tab, the Data Transfer function and then run SurvCADD/Carlson Survey Transfer.

In the present case, just do the following:

- Run Windows Explorer.
- Open the Samples/RealTime/Results folder located on the installation CD-ROM
- Copy the 6 files present in this folder to the "Job" folder of the Tuto_3 project (If you skipped step #4, you need to create this folder first). If asked to do so, overwrite some of the files already present in the folder. This is at least what you should see in the job folder after copying the files:



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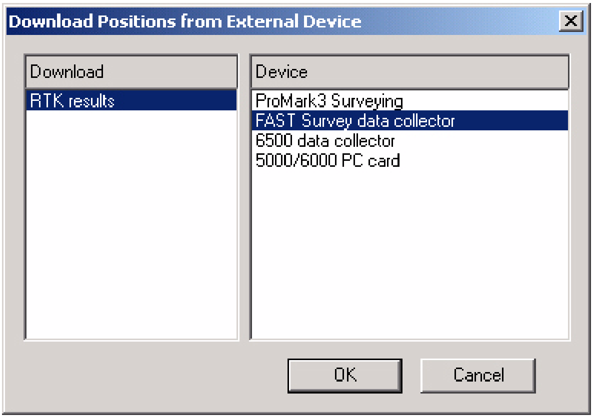
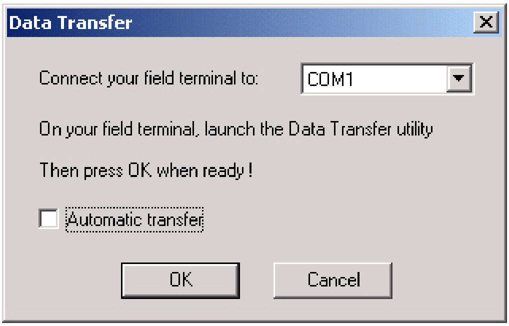
- Come back to GNSS Solutions. In the Command pane, click on the **Import** topic bar, and then on the **Download Positions from External Device** icon. In the dialog box that opens, make the following selections:

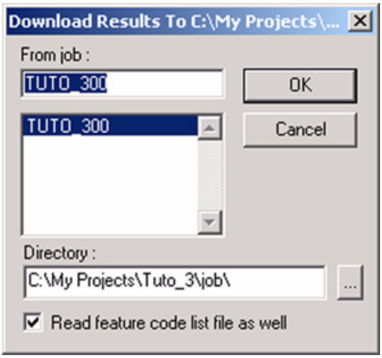


- Click **OK**. The following dialog box opens. Select the port used and clear the **Automatic Transfer** option:

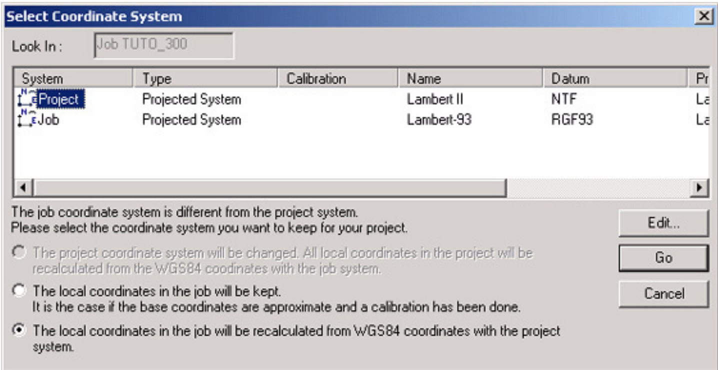


- Click **OK**. The **Connecting to remote system...** message is displayed until communication with the data collector is established. Then the SurvCom dialog box opens.
  If no data collector is connected to the PC, the **Communications Failure** message will appear. In this case, click **OK** to open the SurvCom dialog box.

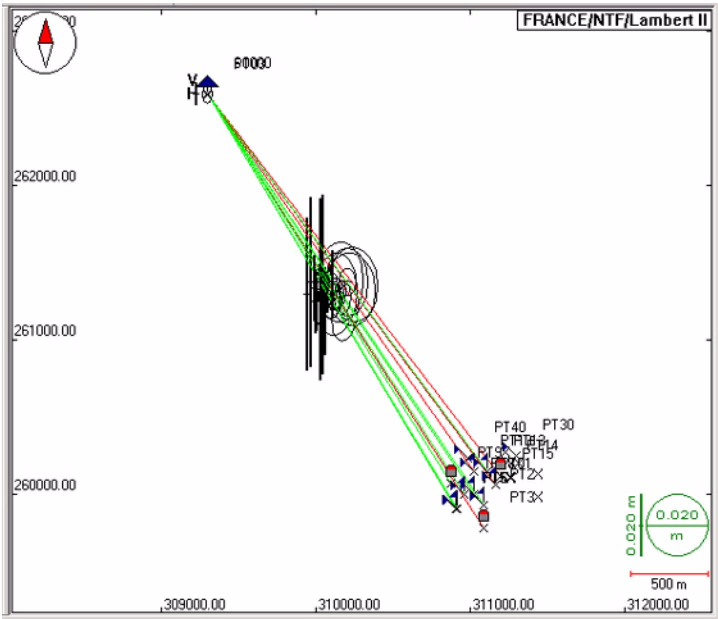
- Click  to close the SurvCom dialog box. The following dialog box now opens:



- Click **OK**. Sometimes, the coordinate system used in the field is different from the one defined in the project. This is the case for the present tutorial. The following dialog box then appears in which you should choose which coordinate system to use in the project. In this example, choose “Project” as shown in the figure below and check the second option in the lower part of the box.

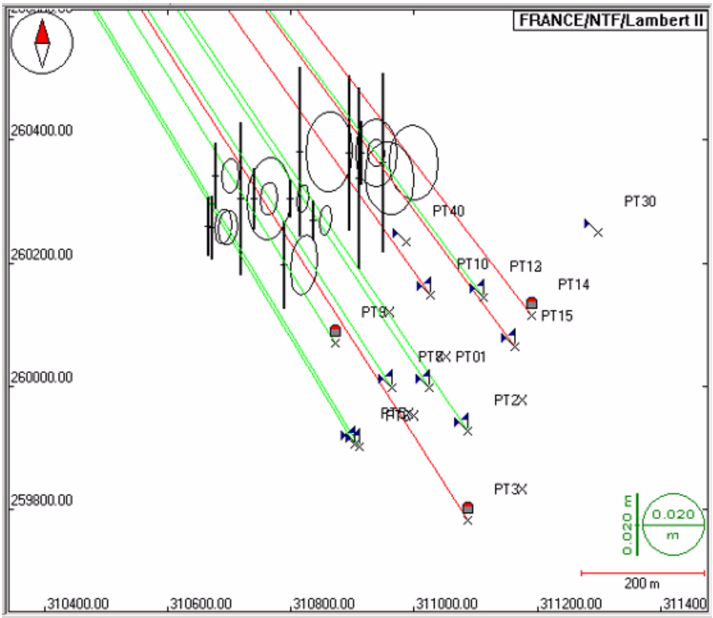


- Click **Go**. This starts the download operation. Once download is complete, the Survey View looks like this:



❑ Step #7: Analyzing the Content of the Project after Downloading Results

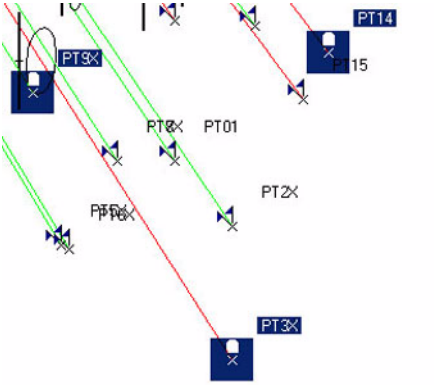
- On the Survey View, zoom in on the area containing points using the zoom-in button from the Map toolbar. To do this, draw a rectangle around this area and release the mouse button. You should then get a view like this one:



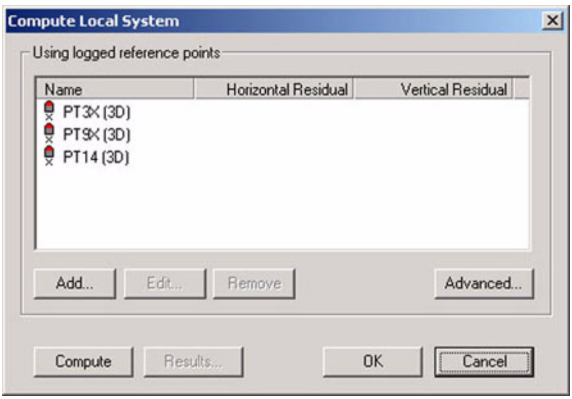
This map shows the location of each surveyed point (staked target: vertical flag+ leaning flag icon; reference: landmark icon; non-staked target: leaning-flag-only icon). The leaning flag is just to remind you that each of these points was initially planned in the project for staking out purposes.

❑ Step #8: Performing Coordinate Calibration

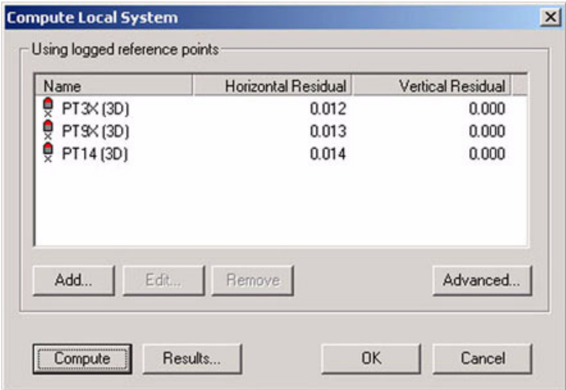
- Zoom in on the area showing the three reference points
- On the Map toolbar, click on and then make a multiple selection of these three points using the Ctrl key:



- On the GNSS Solutions menu bar, select **Project>Coordinate calibration**. The dialog box that opens is as follows:



- Click the **Compute** button to let GNSS Solutions determine the local system. Computation is immediate. Residuals are displayed in the dialog box on computation completion:



Clicking the **OK** button will allow GNSS Solutions to use the newly determined local system as the project's new spatial reference system. Clicking **Cancel** would cause GNSS Solutions to continue using the coordinate system initially chosen for the project. If you click **OK**, GNSS Solutions will then update points and vectors. In the upper-right corner of the map document, the term "Fitted" will then be used to describe the new coordinate system used in the document. This system will also be used at project level.

On the above dialog box, note that the characteristics of the local system can be displayed by clicking the **Results** *button (then see these characteristics on the* **Projection** *and* **System** *tabs).*

- Click **OK** to define the newly determined local system as the project's new spatial reference system.

You can rename the local system through **Project>Edit Settings**.

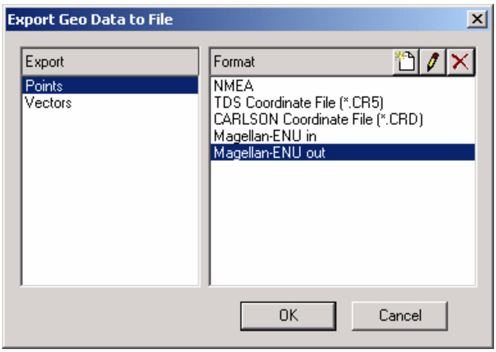
Then click *located on the right of the* **Spatial Reference System** *field. Select the* **System** *tab, edit the* **System name** *field and click* **OK** *twice. The new name will then appear in the upper-right corner of the Survey View.*

Note however that GNSS Solutions does not actually rename the system name. Instead it duplicates the “Fitted” system and then assigns the name you provide to the duplicate.

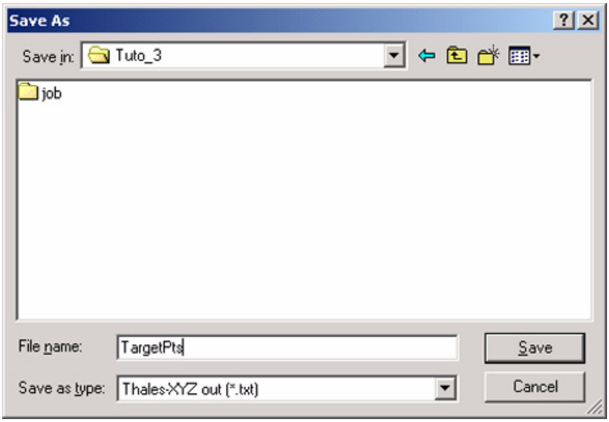
To delete the “Fitted” system, select **Tools>Coordinate Systems**, *select “Fitted” in the list and click* .

❑ Step #9: Exporting Data to a File

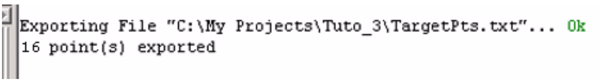
- Click on the **Points** tab located at the bottom of the workbook displayed underneath the Survey View.
- Select the first 16 points on this tab. To do this, click once in the leftmost cell in the first row and then, while holding down the Shift key (⇧), click anywhere in the 16th row.
- In the Command pane, click on the **Export** topic bar and then on the **Export Geo Data to File...** icon
- In the dialog box that appears, make the following two choices:



- Click **OK**. A new dialog box appears asking you to name the export file.
- Choose the project folder where to store the export file and enter “TargetPts” as the file name:



- Click **Save**. A Data export message appears briefly. The end of data export is denoted by the following message in the Output pane:



❑ Step #10: Closing the Project

- Select **File>Close**. This saves and closes the project contained in the workspace, and the workspace as well. End of Tutorial #3.

Tutorial #4: Using the Advanced Functions

(Average time required to complete this tutorial: 8 minutes.)

You are supposed to have run Tutorial #3 before starting Tutorial #4.

This tutorial is designed to show how you can create a new document in a project using the Data Management option. You will discover that the 3 views appearing on the screen when creating a new project are basically documents that GNSS Solutions creates with default settings.

All other documents that you will create in the open project (as is the case with the document created in this tutorial) will necessarily be part of this project.

❑ Step #1: Opening Tutorial #3

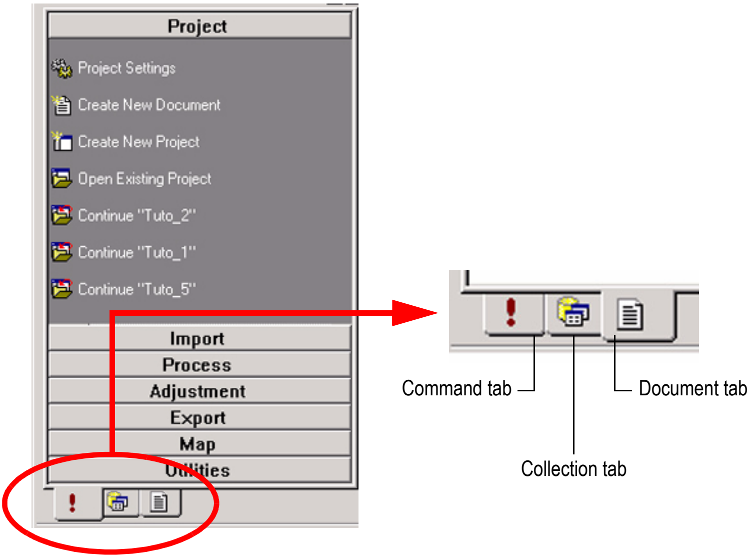
- In the Command pane, click on the **Project** topic bar and then on **Continue “Tuto_3”**. The Tuto_3 project then opens in GNSS Solutions.

❑ Step #2: Enabling the Data Management Option

- From the menu bar, select **Tools>Preferences**.
- In the dialog that opens, check the **Data Management and RTK Functions** options. (Keep the default options enabled –**Guide user on startup** and **Show background map functions**.)
- Click **OK**.

  If you don’t need them in your applications, do not forget to disable these two options after running this tutorial.

- With the Data Management option enabled, the upper-left part of the GNSS Solutions main window looks like this:



The Command pane is now changed into what we call the "Workspace" pane that includes not only the Command tab but also the Collection and Document tabs.

The Command tab includes an additional command that allows you to create new documents in the project. You can create five different types of documents. In this tutorial, we will create a new map document. Notice that among the existing (default) views in the project, the Survey View is a map document, the workbook is a table document and the Time View is a time document.

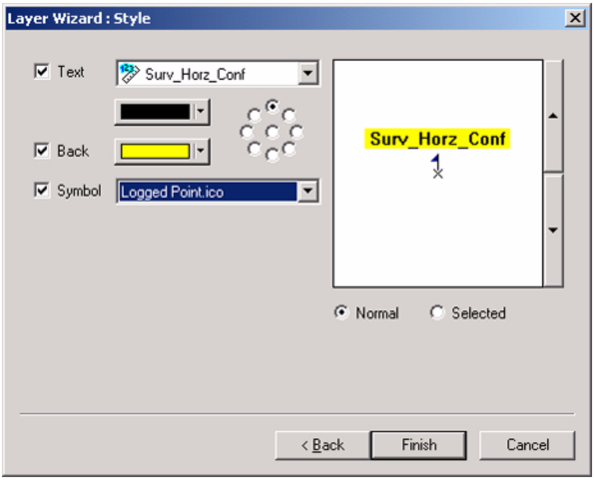
The Collection tab allows you to list the different collections present in the open project, list their properties, etc. We will not address this topic in detail in the present tutorial but you can read more information about collections in the Advanced Features Chapter of the GNSS Solutions Reference Manual.

❑ Step #3: Creating a Map Showing the Precision Results

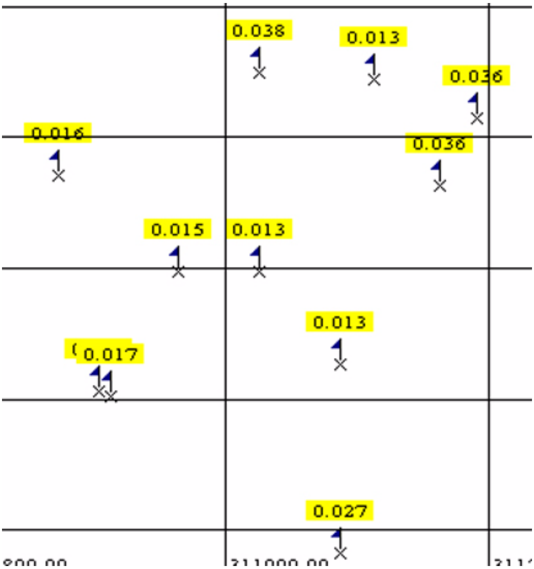
In this step, you will create a map document showing the level of horizontal precision achieved for each of the surveyed points.

- In the Workspace pane, click on the Command tab, then on the **Project** topic bar and then on the **Create New Document** icon.
- On the **Documents** tab of the **New** dialog box that opens, select **Map** in the list and overwrite “Document1” with “Precision results” in the **File Name** field on the right
- Click **OK** to close this dialog box. The new map document now appears in the View pane.
- On the Workspace pane, select the **Collections** tab and then drag and drop the **Points** collection in the new map document. The **Layer Wizard: Data** dialog box opens.

- Click the **Next>** button. In the **Layer Wizard: Style** dialog box that appears, make the following selections:



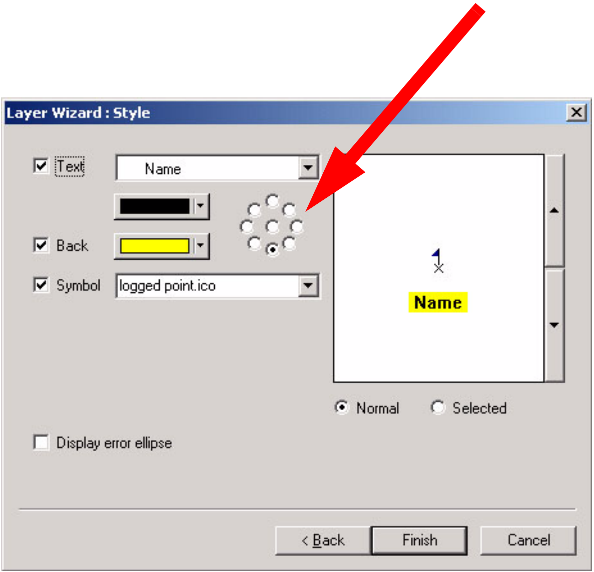
- Click the **Finish** button. The map document should now look like this:



- Right-click anywhere on the map document and select **Legend**. The **Map Properties** dialog box opens.

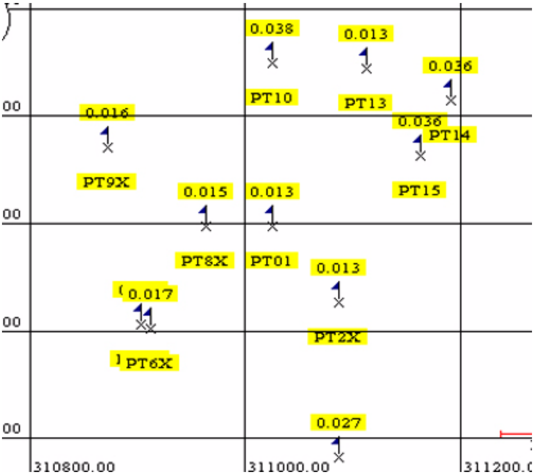
- On the **Legend** tab, click , then select **Points** in the list of collections and then click **OK**

- Click the **Next** button. In the **Layer Wizard: Style** dialog box that appears, make the following selections (don't forget to position the name underneath the point by checking the appropriate button – see arrow below):



- Click the **Finish** button to close this dialog box, and then the **OK** button to close the **Map Properties** dialog box.

The active map document should now show the name and horizontal precision for each point:



The map document can be printed or archived as any other type of document. It can even be appended to the report you will address to your customer.

Any other map document can be created following the instructions of step#3 whenever you need to emphasize a particular aspect of a survey. ❑

GNSS Solutions™

Reference Manual

Includes Tutorial Supplement

Contact Information:

Spectra Precision Division
10355 Westmoor Drive,
Suite #100
Westminster, CO 80021, USA
www.spectraprecision.com

Ashtech S.A.S.
Rue Thomas Edison
ZAC de la Fleuriaye, BP 60433
44474 Carquefou Cedex, FRANCE
www.ashtech.com