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Conventions used: ♣ symbol indicates end of section.

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Glossary

1. Introduction to 4SPack

Presentation

4SPack is a software package designed to support your GPS surveys. 4SPack offers the same functions and benefits from the same assets as its predecessor 3SPack, with even higher levels of performance, compactness and user-friendliness. For example, 4SPack can support both real-time and post-processing surveys in the same project.

4SPack is organized around a powerful database containing all the data created or collected at different stages during your projects.

Any data collection in the project database can be viewed in different forms through a simple drag & drop operation. The documents created in this way consist of tables, maps or graphs and are all attached to the project. Modifying an object in a collection through one of these documents automatically impacts all the other documents present in the project.

4SPack also includes the following functions: import/export, background map projects, network adjustment, report generation, coordinate system management, coordinate transformations tool complying with the OpenGIS Implementation Specification document, etc.

□ **Utility Programs Provided**

Different tools are provided in 4SPack. They are used to:

- Edit /manage coordinate systems used by 4SPack
- 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, 4SPack is delivered with 4 separate utility programs:

- **Pred** 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. Pred provides both qualitative and quantitative figures about the constellation then visible.

You can then use **Pred** to choose the best moment when 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.

Pred 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 GPS/GNSS Thales Navigation receiver, directly from the PC to which it is attached, via the set of proprietary commands available (“\$PDAS” 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 all 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 direct to the Thales Navigation receiver 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.

- **DTR** is used to convert raw data files logged by a Thales Navigation receiver into RINEX-compatible files for further use in any other system compatible with the RINEX format.

Installation

□ Minimum System Requirements

- Personal Computer, PC type
- Operating system: Windows 9x / Me / NT / 2000 / XP
- Processor: Pentium 100 MHz or faster
- RAM: minimum 32 MB, 64 MB recommended
- Space occupied on hard disk (without user data): 16 MB approx.
- CD-ROM drive
- PC Card drive recommended for post-processing
- One or more RS232 serial ports

□ Installing 4SPack

- Close all the applications running in Windows
- Insert the 4SPack CD-ROM in the drive
- 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 4SPack programs and projects, and you agree to the terms of the software license, your computer will complete the installation process.

Overview

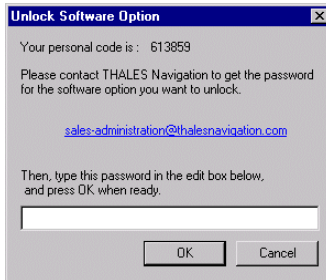
□ Starting / quitting 4SPack

- Starting 4SPack: In the Windows task bar, click on **Start** and select **Programs>Ashtech>4SPack**. The main window opens from which you can start working with 4SPack. See description of this window on the next page.
- Quitting 4SPack: On the 4SPack menu bar, select **File>Exit**. This closes the application. If projects are still open in the main window when running the **Exit** command, then all these projects will be first saved and closed before 4SPack itself is closed.

□ Unlocking a Software Option

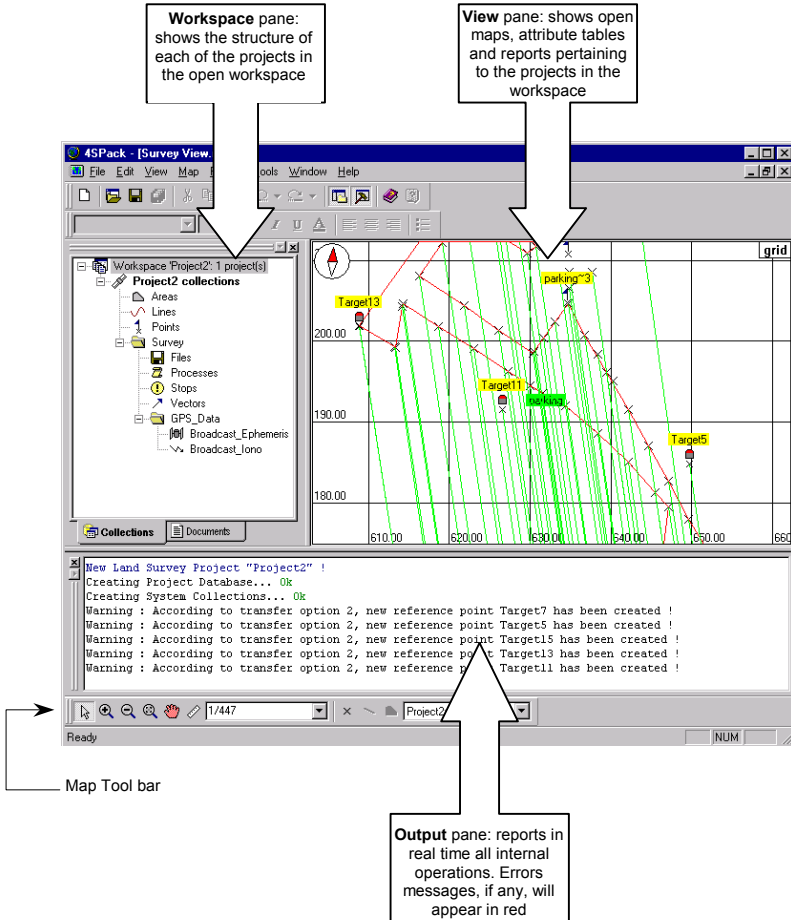
You may need to unlock one of the software options you purchased to be able to use 4SPack according to your needs. To do this:

- On the 4SPack menu bar, select **Help>About 4SPack**
- In the **About 4SPack** dialog box that opens, click on the ...button (on the right). A new dialog box opens, which looks like this:



To get the password needed to run the desired option, click on sales-administration@thalesnavigation.com. This automatically opens a new, predefined e-mail that you just have to complete and send. From your personal code (shown on top of the above dialog box) and the VT number provided by your distributor, we will generate a password for you. Once you get this password, type it in the lower edit box (see dialog box above) and then click **OK**. The software option is now unlocked, ready for use.

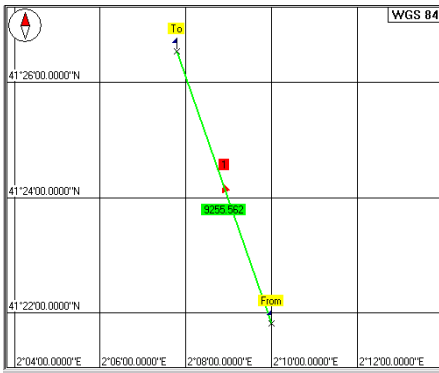
□ Description of the Main Window



□ Viewing surveys on maps

When creating a new land survey project, 4SPack automatically creates default documents among which is a document showing a map of the working area (Survey View document). This document is displayed in the **View** pane:

Map example showing two points and a baseline



Two viewing options exist for the map itself:

- With/without **grid**. The grid is defined as a network of horizontal and vertical lines drawn at regular intervals of distance along the X & Y axes.
- With/without **ruler**. The ruler is defined as the set of coordinate values associated with the grid

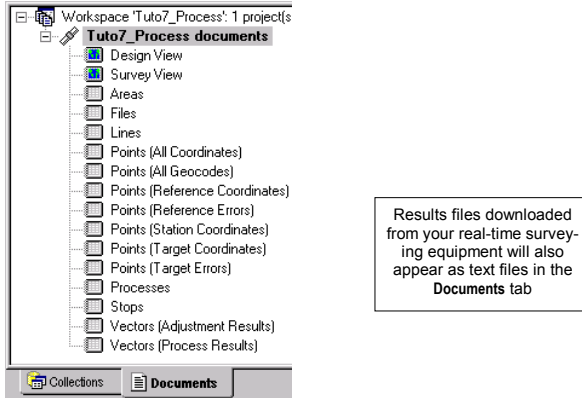
There may be as many map documents as necessary in a project. The defaults (Design View and Survey View) are created when creating the project. To create other maps, use the **File>New** command and then ask for a new map document to be created with a name that you specify.

The default coordinate system used in a map document is always the one defined for the project. You can however use another coordinate system, specifically for this map document using the **Map>View** command.

❑ Default Documents Created in a Project

These are listed in the **Workspace** pane on the **Documents** tab.

Workspace pane showing a project with its default documents:



The default documents include 2 map documents, as explained in the previous page, and 15 table documents. The Design View document only shows the points in the survey whereas the Survey View also shows baselines, vectors and processes.

Each of the default table documents gives a partial representation of the land survey in progress (points, lines, vectors, processes, etc.).

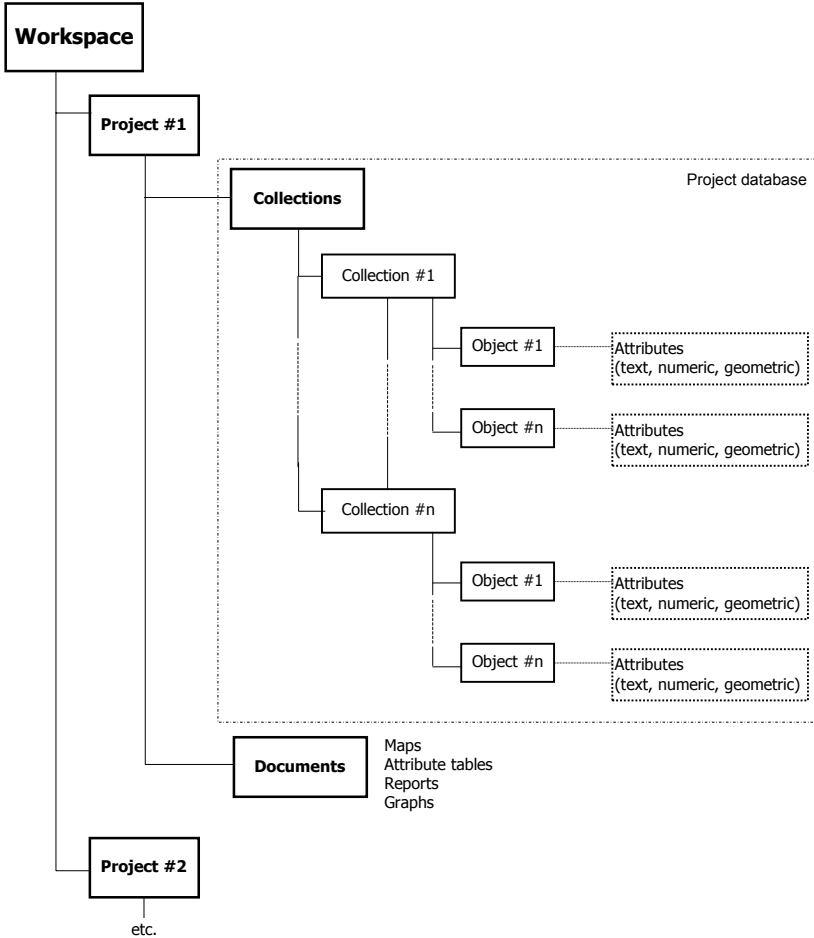
① A very important thing to know about table documents is that they can easily be filled from any collection in the project database through a simple drag & drop operation.

Two more types of documents can be created in a project:

- **Graphs.** Blank graphs are created using **File>New (Graph)**. Graph documents can also be filled through drag & drop, but this time from any data column selected in a table document.
- **Reports.** Blank reports are created using **File>New (Report)**. In addition, project reports can be created using the **Project>Generate Report** command. Project reports are created based on specific templates, depending on the type of generated report.

□ Introducing project databases

The following architecture is implemented by 4SPack every time you create a new project:



Workspace: Contains one or more projects of the same type, or of different types. 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.

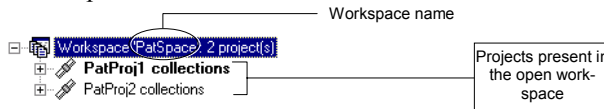
Project: Two types: Land Survey and Background Map. Two tabs are used in the workspace pane to show the content of a project: Collections and Documents.

Collections: Each collection contains a number of objects. 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.

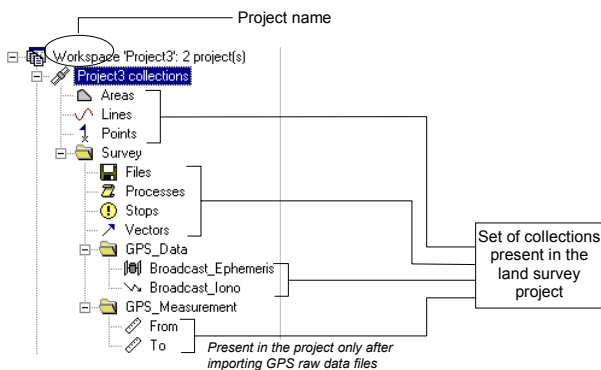
Documents: Four possible types: map, attribute table, report and graph. Documents are created to show the content of the project database from a given angle.

The open workspace and the projects it contains are shown in the left-hand pane of 4SPack.

Example of workspace:



Typical project database architecture:



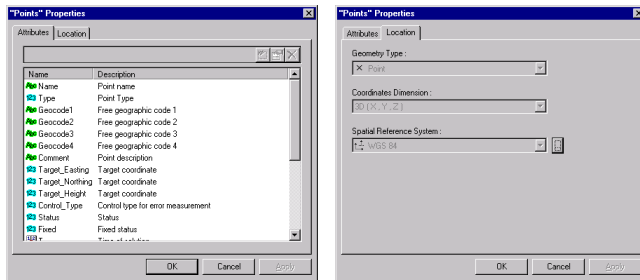
To know more about the different collections you can find in a project, please refer to the Appendices section at the end of the manual.

□ Editing the content of a collection

In the **Collections** tab of the active project, select any collection by clicking on its name (for example click on **Points**). Two different actions are then possible:

1. Listing the attributes characterizing any of the objects present in the collection: after a right click on the selected collection, select **Properties** on the popup menu, or double-click directly on the collection.

The two tabs showing the attributes of a point object (general case):



The first tab lists all the classic attributes (“one-dimensional” text, numeric or Boolean type) whereas the second one shows the geometric attribute (“multi-dimensional”). There are three possible types of geometric attributes:

- Point, defined by a set of 2 or 3 coordinates expressed on a specific coordinate system
- Line, defined by two or more sets of 2 or 3 coordinates expressed on a specific coordinate system
- Area, defined by a close line

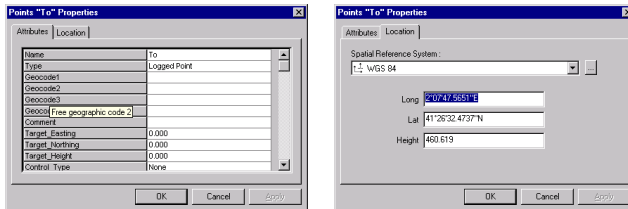
- Editing the objects of a collection: As explained earlier, after creating a table document from **File>New** and opening it in the **View** pane, drag & drop the collection icon on the table:

	Name	Type	Geocodi
1	To	Logged Point	
2	From	Logged Point	

Each row in the table depicts an object from the collection. Use the horizontal scroll bar to browse through the full set of attributes (one attribute per column). For points only, the last columns, i.e. those in the right-hand part of the table, provide the parameters relevant to the geometric attribute of the object.

From this table, you can view the attributes of an object in a different manner: using the mouse cursor, point at the cell in the first column corresponding to the desired object. Once the cursor looks like an arrow (➔), right-click and then select **Properties**. The object attributes are then shown as follows.

Example of the two tabs showing the attributes of a selected point object:



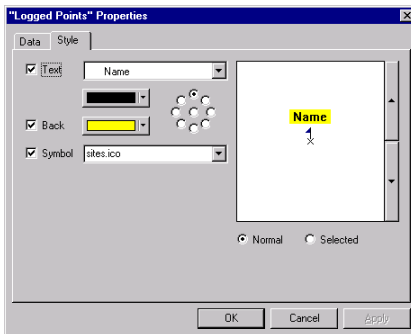
- Other actions are possible from within the “attribute table” document (see section 3)

□ Representing database objects on a map

Almost any collection in a project database can be represented on a map. 4SPack 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 geocodes 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 .../4SPack/Symbols). The user can create new icons if required and store them with the existing ones (see also page 91).
- Icon size
- Name position with respect to the icon.

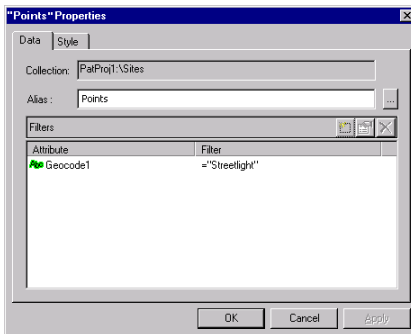
Example of Style dialog box:



For more details, see section 4.

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

Example of a display filter:



In this example, only points for which geocode1=streetslights will appear on the map. For more details see page 97.

We will conclude this section about map documents with the introduction of the following two 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).

□ **Creating survey reports**

4SPack allows you create almost instantly any kind of survey report for your clients or for your archives. These reports being part of the project, they are listed in the **Documents** tab of the Workspace pane (as are all the other types of created documents).

The process of creating survey reports is based on the use of VB Script macros stored in the ...\\Studio\\Macro folder.

□ **Coordinate systems used in a project**

When you create a new project, you are asked to specify a coordinate system. This coordinate system (defined as the “Spatial Reference System”) will be used by default in any new map or table document that you will create in the project.

You can however define a different coordinate system for any of these documents that you create **WITHOUT** affecting the choice of the coordinate system used at project level.

As explained elsewhere in the manual, the process of defining a coordinate system in 4SPack is a bit different from that used in its predecessor 3SPack. ♣

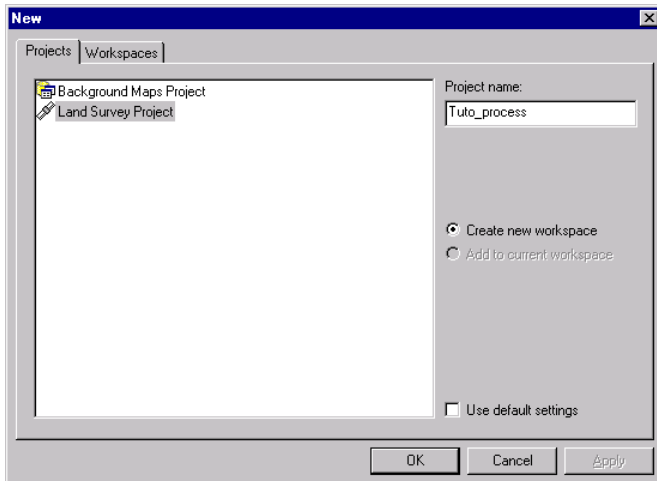
2. Tutorials

Post-Processing a Baseline between two Unknown Points

Incidentally in this example, we will introduce the vector export function using a custom format (Step 6).

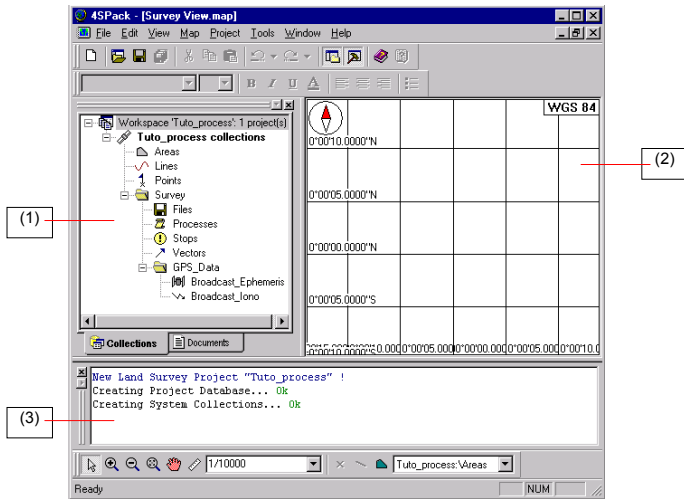
□ First Step: Creating a New Project

- On the 4SPack menu bar, select **File>New**
- In the **New** dialog box that appears, select the **Projects** tab (unless already done)
- In this tab, select **Land Survey Project** on the left
- In the Project name edit box, type a name for the new project. For example, type **Tuto_process**



- Click **OK**. In the **Welcome** dialog box that appears, check the **By entering all settings** check box

- Click **Next**. In the new dialog box that appears, select **WGS84** as the spatial reference system to be used in the new project. Keep the default selection in the **Time zone** field.
- Skip the next three dialog boxes by clicking three times on the **Next** button and then on the **Finish** button. As a result, the new project is created and the following is displayed in the 4SPack main window:



The **Workspace** pane (1) lists the default collections and documents created in the new project. Click on the **Documents** tab in the lower part of this pane to see the default documents. Come back to the project collections by clicking on the **Collections** tab.

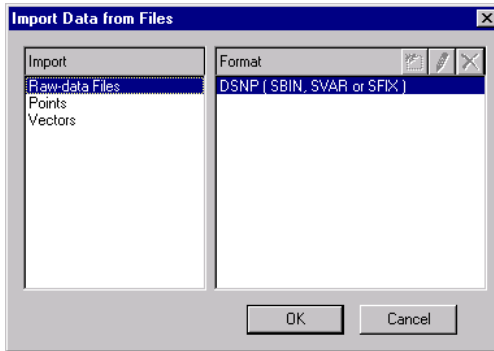
The **View** pane (2) shows an empty map with coordinates corresponding to your choice of spatial reference system.

The **Output** pane (3) shows three lines of messages attesting to the creation of the new project.

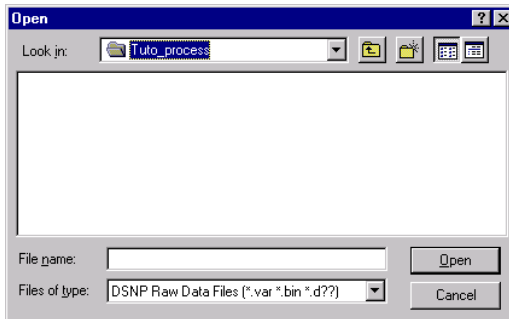
❑ Second Step: Importing Raw Data into the Project

① In this step, you will have to insert the 4SPack installation CD-ROM in the computer's CD drive.

- On the 4SPack menu bar, select **Project>Import Data from Files...**
- In the dialog box that appears, make the following two choices:



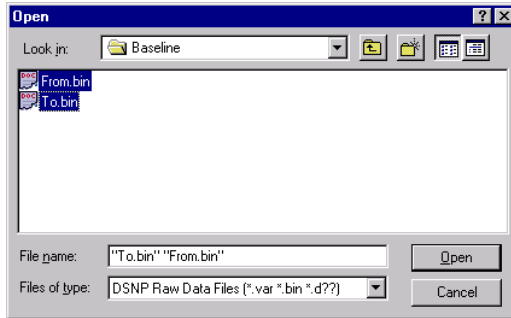
- Click **OK**. This causes the **Open** dialog box to appear:



- Insert the 4SPack CD-ROM in the computer's CD drive
- Using the **Look in** combo box, select the following folder on the 4SPack CD-ROM: `..\Samples\RawData\Baseline`.

This folder contains 2 binary files: From.bin and To.bin. One contains the raw data recorded in the field at one unknown point (static observation), and the other file contains the raw data for the other unknown point (also a static observation).


- Select these two files (using the Shift key to select the 2nd one)



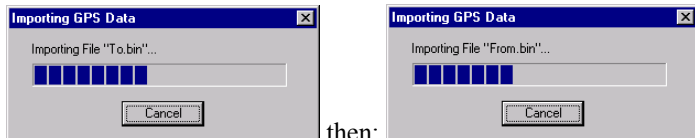
- Click **Open**. The following window then appears:

Import	As File	Site	Date	Time	Dynamic	Antenna Height
To.bin	To_1	To	October 30 1998	15:43:32.0	<input type="checkbox"/>	0.000
From.bin	From_1	From	October 30 1998	13:55:47.0	<input type="checkbox"/>	0.000

This window is maximized so that none of the parameters shown in the right-hand columns of the table can escape your attention.

Click on  to give this window a normal size.

- Accept all the default choices displayed in this box by clicking directly on the **OK** button. 4SPack then starts importing the data files. The following message boxes appear on the screen during the import sequence:



- Let 4SPack complete the import sequence.

❑ Third step: Analyzing the Content of the Project after Importing the Data Files

- At the end of the import sequence, the following can be observed in the 4SPack main window:

1. A new folder (GPS-Measurement) is added to the database, as shown on the Workspace pane

2. The created sites and still unprocessed baseline are represented on the View pane (Survey View map document). The grid coordinates are updated to match the locations of the sites

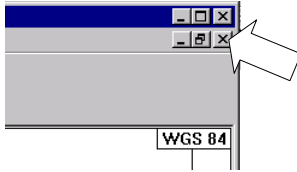
The screenshot displays the 4SPack main window. On the left, the 'Workspace' pane shows a tree view of the project 'Tuto_process' with a 'GPS_Measurement' folder highlighted. The 'View' pane on the right shows a map with a grid and a red dashed line representing a baseline between two points labeled 'To' and 'From'. The 'Output' pane at the bottom shows a log of operations performed during the import process.

```

Analysing file "E:\Samples\RawData\Baseline\To.bin"... Ok
Analysing file "E:\Samples\RawData\Baseline\From.bin"... Ok
Importing DSNP raw data file "E:\Samples\RawData\Baseline\To.bin"... Ok
467 raw record(s), 23 new ephemeris record(s), 1 new ionospheric record
Importing DSNP raw data file "E:\Samples\RawData\Baseline\From.bin"...
1234 raw record(s), 23 new ephemeris record(s), 2 new ionospheric recor
Computing approximate position for file "To"... Ok
(2°07'46.1204"E,41°26'32.0662"N,436.629) Assigned to file and new site
Computing approximate position for file "From"... Ok
(2°09'59.4117"E,41°21'49.4838"N,220.070) Assigned to file and new site
Updating post-process scenario... Ok
1 operation(s) added
  
```


3. All operations performed while importing data are listed on the Output pane

- On the Workspace pane, come back to the default documents list by clicking on the **Documents** tab.
- When creating a new project, the Survey Map document (2nd position in the list) shows on the View pane. Close this document by selecting **File>Close map** on the menu bar or by clicking the following button under the 4SPack title bar:



- On the Workspace pane, double-click on the **Points (All Coordinates)** document. This document, which opens on the View pane, provides the approximate coordinates of the two points now in the project. These two points were created following the import operation:

	Name	Long	Lat	Height	Status
1	To	2°07'46.1204"E	41°26'32.0662"	436.629	Approximate
2	From	2°09'59.4117"E	41°21'49.4838"	220.070	Approximate

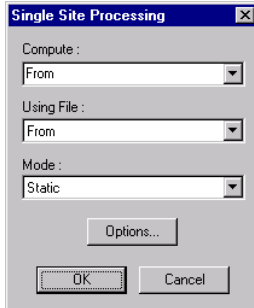
- Close this document by clicking on 
- On the Workspace pane, double-click on the **Processes** document. This document, which opens on the View pane, provides the definition of a baseline that can be processed by 4SPack in view of the data now available in the database:

	Num	Reference	Reference_File	Rover	Rover_File	Mode
1	1	From	From	To	To	Static

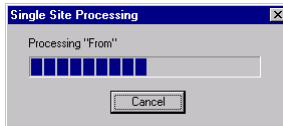
- Close this document by clicking on 

❑ Fourth Step: Refining the Location of the “From” Point

- On the 4SPack menu bar, select **Project>Process Single Site...**
- In the **Single Site Processing** dialog box that appears, make the following choices:



- Click **OK**. 4SPack starts computing the coordinates of the “From” point. The following message box is then displayed:



At the end of this processing, the following lines can be read on the Output pane:

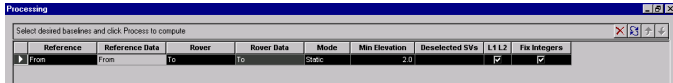
```
Computing site "From" using observation "From"... Ok
1233 points averaged
(2°09'58.9363"E,41°21'48.8470"N,241.317) Assigned to site "From"
```


- If you now open the **Points (All Coordinates)** document from the **Documents** tab on the Workspace pane, you will notice that the “From” point is now declared as “Averaged” and its coordinates have changed:

	Name	Long	Lat	Height	Status
1	To	2°07'46.1204"E	41°26'32.0662"	436.629	Approximate
2	From	2°09'58.9363"E	41°21'48.8470"	241.317	Averaged

□ Fifth Step: Processing the Baseline

- On the 4SPack menu bar, select **Project>Process Baselines...** The following window appears:



This window is maximized so that none of the parameters shown in the right-hand columns of the table can escape your attention. You can click on  to give this window a normal size.

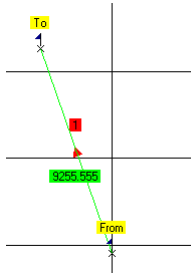
- Click on the **Process** button. This starts the baseline processing. A message box is displayed providing information on the computation in progress (baseline numbers, computation steps, etc.). At the end of this processing, the following lines can be read on the Output pane:

```
Computing site "To" using file "To" from site "From" using file "From"...
L1/L2 Float solution : (2°07'47.0905"E,41°26'31.8354"N,481.896)...
WideLane solution : (2°07'47.0891"E,41°26'31.8340"N,481.820)...
L1/L2 Fixed solution : (2°07'47.0900"E,41°26'31.8356"N,481.839)...
Final fixed solution : (2°07'47.0900"E,41°26'31.8356"N,481.839) Assigned to site "To"
459 records used ...
Updating Vector from site "From" to site "To" ... Ok
```

- To read the characteristics of the vector resulting from the baseline processing, select the **Documents** tab on the Workspace pane and open the **Vectors (Process Results)** document by double-clicking on this document name.

	DX	DY	DZ	Length	SdX	SdY	SdZ	RMS
1	-5474.991	-3270.20	6707.870	9255.555	0.028	0.013	0.027	0.041

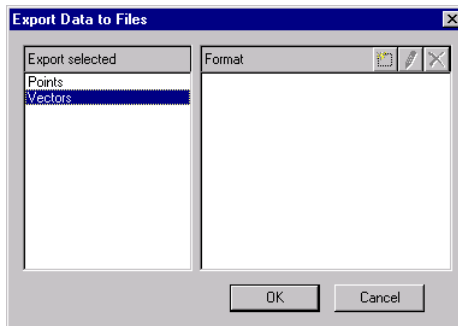
- In addition, if you open the **Survey View** document on the View pane, the value of baseline length will appear on the map:




□ Sixth Step: Exporting the Processed Vector to a File

(This step includes creating a custom format for data export.)

- Unless already done, open the **Vectors (Process Results)** document and select (highlight) row #1 containing the vector results
- On the 4SPack menu bar, select **Project>Export Data to File...**
- In the dialog box that appears, select **Vectors**:



- To create a custom format, in the **Format** list box, click on . This opens the **Custom Format** window.
- Follow the instructions provided in this window to create a new format.

- To become familiar with all the buttons and functions present in this window, try to re-create the format defined in the Format Header and Format Body boxes below:

The screenshot shows a dialog box for creating a custom format. The 'Name' field contains 'PatsFormat'. The 'Extension' field contains 'txt'. There are two radio buttons: 'Format Header' (unselected) and 'Format Body' (selected). Below these are instructions for field selection. The 'Format Header' section contains a text box with the following text:

```

{$Project:12}\New Surveyors Ltd
Station Rover      DX      DY      DZ      Length  PDOP
  
```

The 'Format Body' section contains a text box with the following text:

```

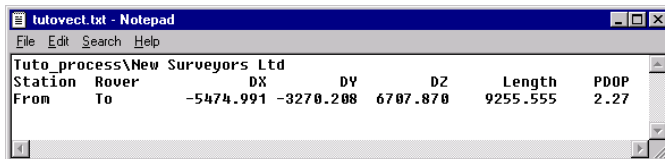
[Reference:9][Rover:9][DX:10:3][DY:10:3][DZ:10:3][Length:12:3][PDOP:8:2]
  
```

For more information on this dialog box, refer to page 105

- Once the custom format has been created, click **OK**. The **Export Data to Files** dialog box appears again, this time with “Patsformat” selected to be the custom format used for data export

- Click **OK**. In the **Save As** dialog box that appears, type a name for the export file (for example: “tutovect”) and then click on the **Save** button. 4SPack then creates the export file and saves it to the project folder as a text file (txt).

If you edit this file using Notepad for example, you would get the following:



```
tuto_process\New Surveyors Ltd
Station Rover DX DY DZ Length PDOP
From To -5474.991 -3270.208 6707.870 9255.555 2.27
```

- To complete the first example, close the project. To do this, on the 4SPack menu bar, select **File>Close Workspace**. This closes the project contained in the workspace, and the workspace as well. Note that all the changes made in the project and all the environmental parameters pertaining to the workspace are directly and automatically saved before effectively closing them.

Post-Processing a Point Network including two Known Points

This is a new example in which redundancy exists in the observations made in the field. This means that most surveyed points will be involved in the processing of several vectors.

To produce a single, accurate solution for each of the surveyed points, we will therefore perform a “network adjustment” step in which the two known points involved will be held fixed so that the surveyed points be accurately determined in relation to these known points.

Incidentally, in this example, we will introduce the “As Workbook” viewing option in the 4th step. This option allows you to know at any moment which documents are currently open on the View pane while allowing you to optimize the use of this pane for displaying a single document. This option can also be combined with the commands available on the Window menu (Tile Horizontally, Tile vertically, Cascade).

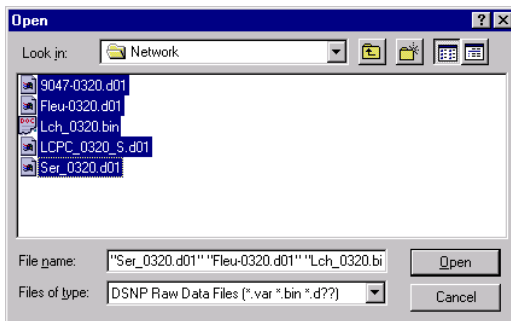
□ **First Step: Creating a New Project**

- Create a new project (“Tuto2_process” for example). Follow the same instructions as in the previous example (see page 15).

❑ Second Step: Importing Raw Data into the Project

① In this step, you will have to insert the 4SPack installation CD-ROM in the computer's CD drive.


- Follow the same instructions as in the previous example (see page 17) to import the following raw data files stored in \Samples\RawData\Network on the CD-ROM:



- Click **Open**. The following window appears:

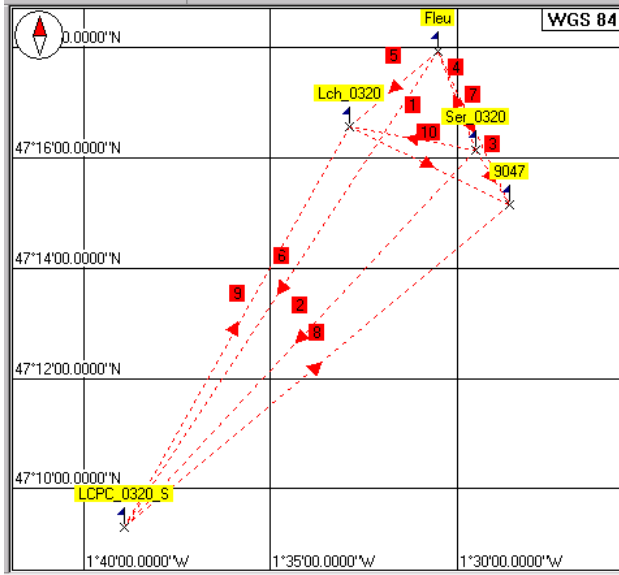
Import	As File	Site	Date	Time	Dynamic	Antenna Height
<input checked="" type="checkbox"/> Ser_0320.d01	Ser_0320	Ser_0320	March 20 2002	10:56:52.0	<input type="checkbox"/>	0.000
<input checked="" type="checkbox"/> Fleu-0320.d01	Fleu	Fleu	March 20 2002	10:54:23.0	<input type="checkbox"/>	0.000
<input checked="" type="checkbox"/> Lch_0320.bin	Lch_0320	Lch_0320	March 20 2002	10:57:36.0	<input type="checkbox"/>	0.000
<input checked="" type="checkbox"/> LCPC_0320_S.d01	LCPC_0320_S	LCPC_0320_S	March 20 2002	10:54:46.0	<input type="checkbox"/>	0.000
<input checked="" type="checkbox"/> 9047-0320.d01	9047	9047	March 20 2002	10:55:06.0	<input type="checkbox"/>	0.000

This window is maximized so that none of the parameters shown in the right-hand columns of the table can escape your attention.

Click on  to give this window a normal size.

- Click **OK** in this window to allow 4SPack to import these files.

- After data import, the View pane shows the following:



□ Third Step: Editing the Control Points

In this project, two known points are used whose coordinates are accurately known (reference coordinates):

Point “Ser_0320”:

Long: 1°29'30.6944”W

Lat: 47°16'08.4190”N

Height: 92.590 m



Point “LCPC_0320”:

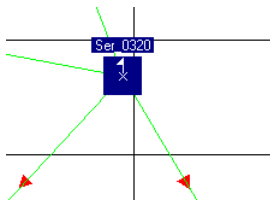
Long: 1°38'53.54844”W

Lat: 47°09'17.3384”N



Height: 91.757 m

In this step, we will edit the control points so that the reference coordinates listed above be assigned to them. In addition, we will hold them fixed so that the coordinates of these control points cannot be changed during the baseline processing run in the next step.

- On the map toolbar, click  (toolbar in the lower part of the 4SPack window)
- On the View pane, click repeatedly on the point “Ser_0320” until it is clearly visible (zoom-in operation)
- On the map toolbar, click 
- On the View pane, select (highlight) the point “Ser_0320” by clicking on the point name:



- Right-click on this point and select **Properties**


- Change the coordinates and attributes as indicated below:
 - Location tab:**
 - Long: 1°29'30.6944"W instead of 1°29'30.6524"W
 - Lat: 47°16'08.4190"N instead of 47°16'08.4868"N
 - Height: 92.590 instead of 104.743
 - Attributes tab:**
 - Fixed** field: in the combo box opposite this field, select **Horizontal and vertical fixed** to protect the known coordinates from change
- Click **OK** to accept changes
- On the Map toolbar, click  to adjust the map scale so that all the points on the map can be viewed on the View pane.
 -  is then automatically selected on the map toolbar
- Select "LCPC_0320" by clicking on the point name
- Right-click on this point and select **Properties**
- Change the coordinates and attributes as indicated below:
 - Location tab:**
 - Long: 1°38'53.5484"W instead of 1°38'53.4138"W
 - Lat: 47°09'17.3384"N instead of 47°09'17.5473"N
 - Height: 91.757 instead of 115.275
 - Attributes tab:**
 - Fixed** field: in the combo box opposite this field, select **Horizontal and vertical fixed** to protect the known coordinates from change
- Click **OK** to close the **Properties** dialog box

□ Fourth Step: Processing all the Baselines

- On the 4SPack menu bar, select **Project>Process Baselines...** The following window appears:

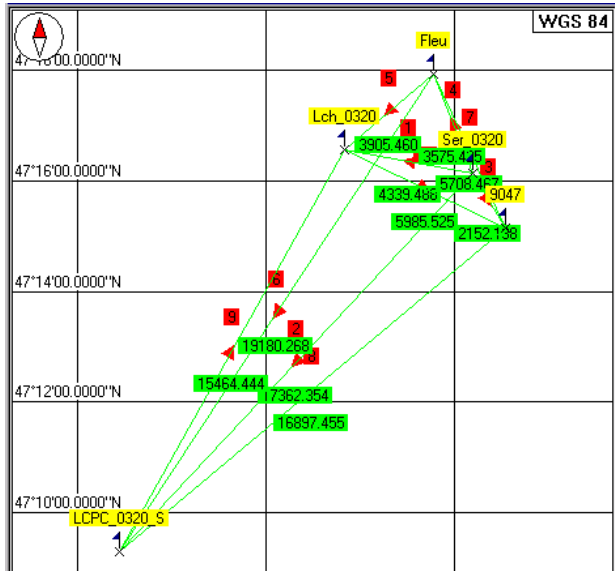
Reference	Reference Data	Rover	Rover Data	Mode	Min Elevation	Deselected SVs	L1 L2	Fix Integers
Ser_0320	Ser_0320	Lch_0320	Lch_0320	Static	2.0		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Ser_0320	Ser_0320	LCP_C_0320_S	LCP_C_0320_S	Static	2.0		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Ser_0320	Ser_0320	F9u	F9u	Static	2.0		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
F9u	F9u	Lch_0320	Lch_0320	Static	2.0		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
F9u	F9u	LCP_C_0320_S	LCP_C_0320_S	Static	2.0		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
F9u	F9u	F9u	F9u	Static	2.0		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
LCP_C_0320_S	LCP_C_0320_S	F9u	F9u	Static	2.0		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
LCP_C_0320_S	LCP_C_0320_S	Lch_0320	Lch_0320	Static	2.0		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Lch_0320	Lch_0320	F9u	F9u	Static	2.0		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

This window gathers all the baseline processes that can possibly be run. These processes were identified by 4SPack during the second step (data import) (See principles on page 111 and next one, particularly points 6. and 7.).

This window is maximized so that none of the parameters shown in the right-hand columns of the table can escape your attention. You can click on  to give this window a normal size.

- Accept the content of this window by clicking directly on the **Process** button. This starts the baseline processing (Notice: depending on the performance level of your computer, this processing may take between 10 and 30 minutes).

On completion of this processing phase, the following is displayed on the View pane:



- On the 4SPack menu, select **View>As Workbook** to check this option. The View pane now appears as a workbook, i.e. with a tab in the lower part of the pane indicating the name of the open document (which here is “Survey View”)
- To read the characteristics of the vectors resulting from the base-line processing, select the **Documents** tab on the Workspace pane and open the **Vectors (Process Results)** document by double-clicking on this document name.

As a result, this document now appears as a second tab in the View pane. Navigate in the document using the horizontal scroll bar associated to the tab.

	Time_Span	Solution	DX	DY	DZ	Length	SdX	SdY
1	00:34:34	L2 Fixed	-694.483	-4250.261	533.062	4339.488	0.010	0.000
2	00:34:16	L2 Fixed	8988.065	-12094.940	-9624.295	17362.354	0.020	0.010
3	00:32:15	L2 Fixed	1365.340	1071.798	-1272.318	2152.138	0.006	0.000
4	00:34:42	L2 Fixed	-2482.996	-1236.177	2256.161	3575.425	0.008	0.000
5	00:33:39	L2 Fixed	1788.629	-3014.084	-1723.103	3905.460	0.007	0.000
6	00:36:01	L2 Fixed	11470.880	-10858.958	-10860.470	19180.268	0.020	0.010
7	00:33:41	L2 Fixed	3848.337	2307.975	-3528.477	5708.467	0.012	0.000
8	00:33:41	L2 Fixed	-7622.658	13166.886	7352.019	16897.455	0.019	0.010
9	00:33:13	L2 Fixed	-9682.465	7844.803	9157.400	15464.444	0.027	0.010
10	00:31:12	L2 Fixed	2059.804	5322.060	-1805.380	5885.525	0.011	0.000

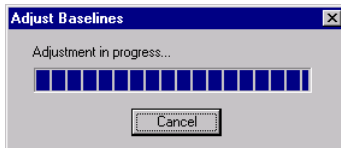
Record 0 | Survey View... | Vectors [Pro...]

- To come back to the survey map, simply click on the **Survey View...** tab.

□ Fifth Step: Performing Network Adjustment

In this step, as there is some redundancy in the measurements performed in the field (each surveyed point is involved in two or three vectors computed in the 4th step), 4SPack will optimize the solution of each computed vector through least-square processing.

- On the 4SPack menu bar, select **Project>Adjust Baselines...** This starts the network adjustment procedure immediately as indicated by the message box that appears on the screen:



During this phase, 4SPack adjusts all the vectors computed previously in the third step.

- To know the impact of the network adjustment on the vectors, open the **Vectors (Adjustment Results)** document. Read the residuals of the network adjustment after dragging the horizontal scroll bar fully to the right.

	Adjusted_DX	Adjusted_DY	Adjusted_DZ	Adjusted_Length	DX_Residual	DY_Residual	DZ_Residual	Adjusted
1	-694.465	-4250.262	533.084	4339.489	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>
2	8989.063	-12094.942	-8624.293	17362.354	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>
3	1965.339	1071.797	-1272.316	2152.135	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>
4	-2482.997	-1236.178	2256.163	3575.427	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>
5	1788.528	-3014.085	-1723.101	3905.460	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>
6	11470.878	-10858.959	-10880.489	19180.267	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>
7	3848.336	2307.973	-3528.475	5708.464	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>
8	-7622.860	13166.885	7352.021	18897.456	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>
9	-9682.466	7844.802	9157.402	15464.446	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>
10	2059.803	5322.058	-1805.378	5985.523	-0.001	-0.001	0.002	<input checked="" type="checkbox"/>

Record: 0

Survey Vie... Vectors (Pro... Vectors (Adj...

A good network adjustment is characterized by low residuals of approximately the same magnitude as well as successful Tau test for each adjusted vector (all buttons checked in the Tau test column). Note that these two criteria are met in this example.

□ Sixth Step: Viewing the Results in a Specific Spatial Reference System

- Select **Project>Edit Settings** and, unless already done, select the **Region** tab
- Select “Lambert II” as the new spatial reference system and click **OK**. 4SPack then automatically transforms the coordinates of the all points surveyed into the new system. When this operation is complete, you can read the new coordinates in the **Points (All coordinates)** document. The **Survey View** document (default map) is also updated to reflect the change of spatial reference system.

Note that selecting a new spatial reference system does not impact on the vector components (see **Vectors...** documents) as these are all expressed in ECEF.

- To complete this example, on the 4SPack menu bar, select **File>Close Workspace**. This saves and closes the project contained in the workspace, and the workspace as well.

"Stop & Go" Project

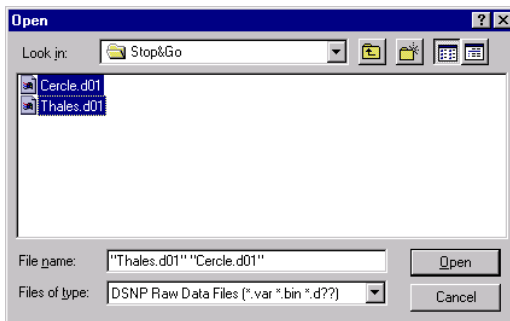
❑ First Step: Creating a New Project

- Create a new project ("Tuto3_process" for example). Follow the same instructions as in the previous examples (see page 15).

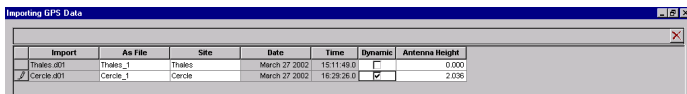
❑ Second Step: Importing Raw Data into the Project

① In this step, you will have to insert the 4SPack installation CD-ROM in the computer's CD drive.

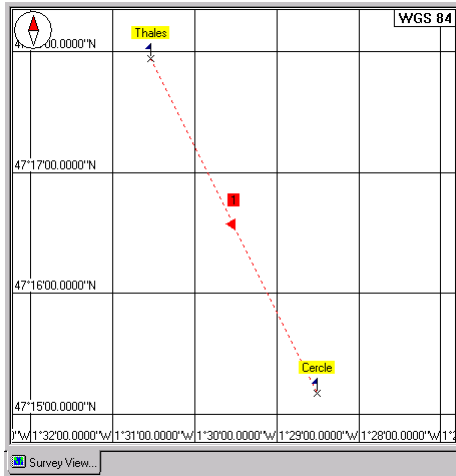
- Follow the same instructions as in the previous examples (see page 17) to import the following raw data files stored in \Samples\RawData\Stop&Go on the CD-ROM:



- Click **Open**. The **Importing GPS data** window appears
- Check the "Dynamic" check box for the "Cercle" site:



- Click **OK** in this window to allow 4SPack to import these files.
- After data import, the View pane shows the following:



□ Third Step: Analyzing the Content of the Project after Importing the Data Files

- On the Workspace pane, click on the **Documents** tab and double-click on the **Stops** document:

	Name	Start_Time	Time_Span	Raw_data_file	Antenna_Height
1	1001	March 27 2002 16:31:58.90	00:00:00	Cercle	2.036
2	1002	March 27 2002 16:35:34.10	00:00:00	Cercle	2.036
3	200	March 27 2002 16:36:21.90	00:00:00	Cercle	2.036
4	201	March 27 2002 16:36:49.90	00:00:00	Cercle	2.036
5	202	March 27 2002 16:38:07.70	00:00:00	Cercle	2.036
6	203	March 27 2002 16:38:36.30	00:00:00	Cercle	2.036
7	204	March 27 2002 16:40:13.10	00:00:00	Cercle	2.036

This document shows the list of static occupation times found by 4SPack in the "Cercle" file when importing this file to the project database.

- On the Workspace pane, double-click on **Processes** to open this document on the View pane. As you can see, 4SPack understands that a Stop & Go processing can be run between the two considered points.

	Number	Reference	Reference_File	Rover	Rover_File	Mode
1	1	Thales	Thales	Cercle	Cercle	Stop & Go

Record 0

Survey Vie... Stops.tbl Processes.tbl

- On the Workspace pane, double-click on **Points (All coordinates)** to open this document on the View pane. As you can see, 4SPack only lists two points for which it gives approximate coordinates (determined from the first measurements found in the corresponding data files)

	Name	Long	Lat	Height	Status	Offset_Mode
1	Thales	1°30'32.5416"W	47°17'56.4095"N	92.375	Approximate	No offset None
2	Cercle	1°26'30.3730"W	47°15'10.3975"N	52.202	Approximate	No offset None

Record 0

Survey Vie... Stops.tbl Processes.tbl Points (All Co...)

□ Fourth Step: Editing the Station Coordinates

In this project, the point used ("Thales") has precisely the following coordinates:

Long: 1°30'32.4817"W
 Lat: 47°17'56.5190"N
 Height: 91.051 m

- In the Survey View map document, select (highlight) the point "Thales" by clicking on the point name
- Right-click on this point and select **Properties**

- Change the coordinates as indicated below:

Location tab:

Long: 1°30'32.4817"W instead of 1°30'32.5416"W

Lat: 47°17'56.5190"N instead of 47°17'56.4095"N

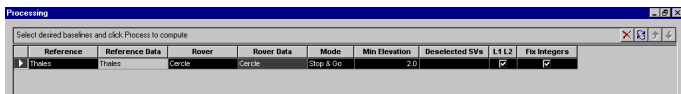
Height: 91.051 instead of 92.375 m

Note that you do not need to fix the station position, as it is not involved in any baseline

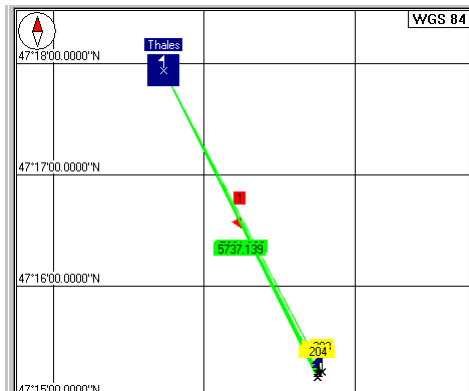
- Click **OK** to close the **Properties** dialog box.

□ Fifth Step: Running the Stop & Go Processing


- On the 4SPack menu bar, select **Project>Process Baselines...** The following window appears:

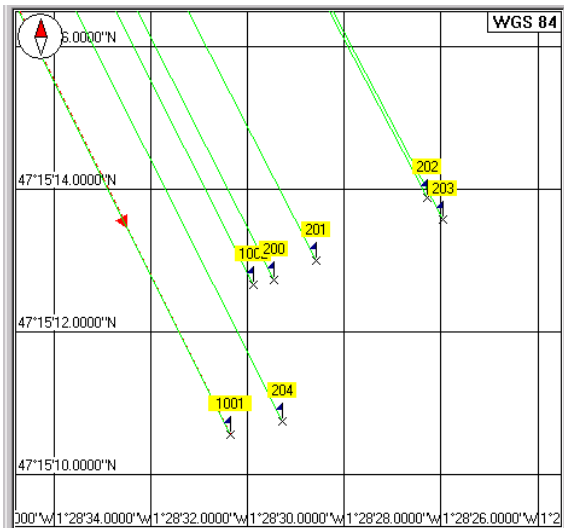


- Click on the **Process** button to start the Stop & Go processing
On completion of this processing phase, the following is displayed on the View pane:



❑ **Sixth Step: Analyzing the Results of the Stop & Go Processing**

- On the map toolbar, click  (toolbar in the lower part of the 4SPack window)
- On the View pane, click repeatedly on the lower point "204" until the set of points created by the Stop & Go processing can be properly seen:



- On the Workspace pane, double-click on **Vectors (Process Results)** to open this document on the View pane. This document lists 7 computed vectors corresponding to the 7 static occupations initially detected in the "Cercle" data file:

	Reference	Rover	Start_Time	Time_Sp	Solution	DX
1	Thales	1001	March 27 2002 16:31:58.90	00:00:00	L2 Fixed	381
2	Thales	1002	March 27 2002 16:35:34.10	00:00:00	L2 Fixed	378
3	Thales	200	March 27 2002 16:36:21.90	00:00:00	L2 Fixed	378
4	Thales	201	March 27 2002 16:36:49.90	00:00:00	L2 Fixed	378
5	Thales	202	March 27 2002 16:38:07.70	00:00:00	L2 Fixed	373
6	Thales	203	March 27 2002 16:38:36.30	00:00:00	L2 Fixed	374
7	Thales	204	March 27 2002 16:40:13.10	00:00:00	L2 Fixed	380

Record 1

Survey Vie... Stops.tbl Processes.tbl Points (All C... Vectors (Pro...

- And the **Points (All coordinates)** document now contains 9 points (station "Thales", approximate initial point "Cercle" and the 7 points corresponding to the 7 static occupations initially detected in the "Cercle" data file):

	Name	Long	Lat	Height	Status	
1	Thales	1*30'32.4617"W	47*17'56.5190"	91.051	Set	Nc
2	Cercle	1*28'30.3425"W	47*15'10.5630"	61.951	Surveyed (L2 Fixed)	Nc
3	1001	1*28'30.3435"W	47*15'10.5632"	61.947	Surveyed (L2 Fixed)	Nc
4	1002	1*28'29.8660"W	47*15'12.6560"	63.003	Surveyed (L2 Fixed)	Nc
5	200	1*28'29.4409"W	47*15'12.7206"	63.030	Surveyed (L2 Fixed)	Nc
6	201	1*28'28.5877"W	47*15'12.9995"	62.921	Surveyed (L2 Fixed)	Nc
7	202	1*28'26.2784"W	47*15'13.8699"	63.141	Surveyed (L2 Fixed)	Nc
8	203	1*28'25.9646"W	47*15'13.5718"	62.444	Surveyed (L2 Fixed)	Nc
9	204	1*28'29.2784"W	47*15'10.7488"	61.178	Surveyed (L2 Fixed)	Nc

Record 0

Survey Vie... Stops.tbl Processes.tbl Points (All Co... Vectors (Pro...

- Select **File>Close Workspace**. This saves and closes the project contained in the workspace, and the workspace as well.

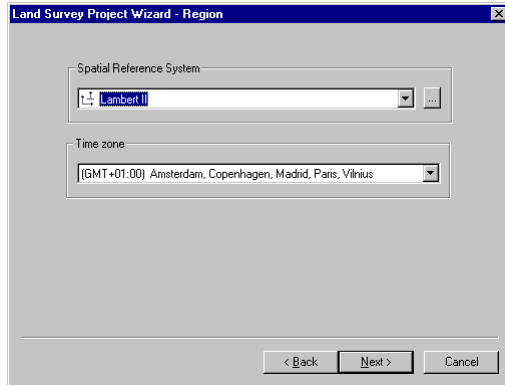
Real-Time Project: Staking Out Target Points

In this example, the target points to be surveyed are not created in the project, although this would be possible using the map toolbar. Target points are made available in the form of a text file that we have especially prepared for this example. We will also bypass the field survey step, which does not fall within the scope of 4SPack. We will however provide you with a results file as if you had performed the field survey, so that the post-survey steps can be run with 4SPack.

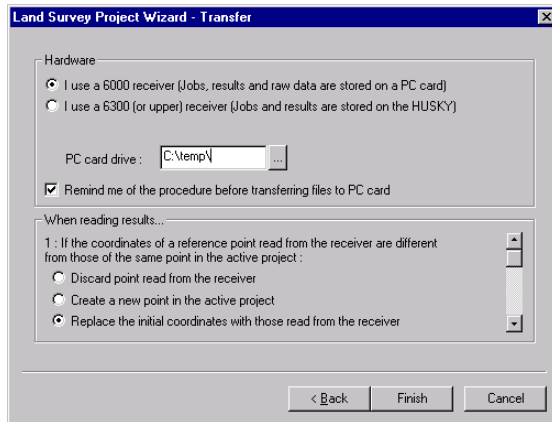
□ First Step: Creating a New Project

- On the 4SPack menu bar, select **File>New**.
- In the **New** dialog box that appears, select the **Projects** tab (unless already done).
- In this tab, select **Land Survey Project** on the left.
- In the Project name edit box, type a name for the new project. For example, type **Tuto4_process**.
- Click **OK**. In the **Welcome** dialog box that appears, check the **By entering all settings** check box.
- Click **Next**. In the new dialog box that appears, select **Lambert II** as the spatial reference system to be used in the new project.

Keep the default selection in the **Time zone** field (GMT+01:00)



- Click **Next** three times
- In the **Transfer** tab, check the 6000 receiver option allowing data exchange with a PC card (PCMCIA) or the hard disk on your PC. In the **PC card drive** field, type “C:\Temp\” to define this folder as if it were the PC Card drive:



Leave all the other settings unchanged.

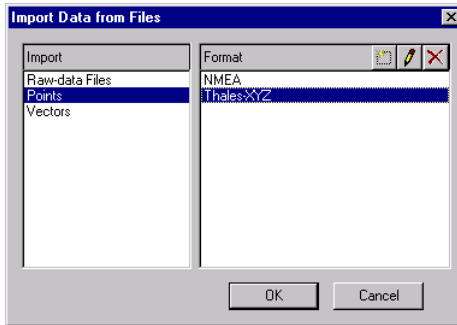
- Click **Finish** to allow 4SPack to create the new project.

❑ Second Step: Importing the Target Points from a File

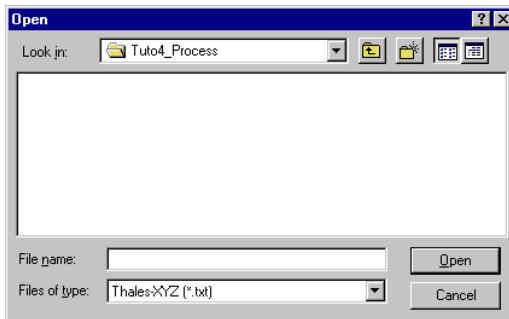
① In this step, you will have to insert the 4SPack installation CD-ROM in the computer's CD drive.

Assuming the characteristics of the target points to be surveyed have earlier been stored in a file, do the following:

- On the 4SPack menu bar, select **Project>Import Data from Files...**
- In the dialog box that appears, make the following two choices:

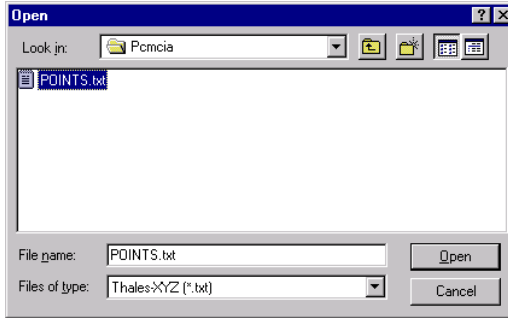


- Click **OK**. This causes the **Open** dialog box to appear:

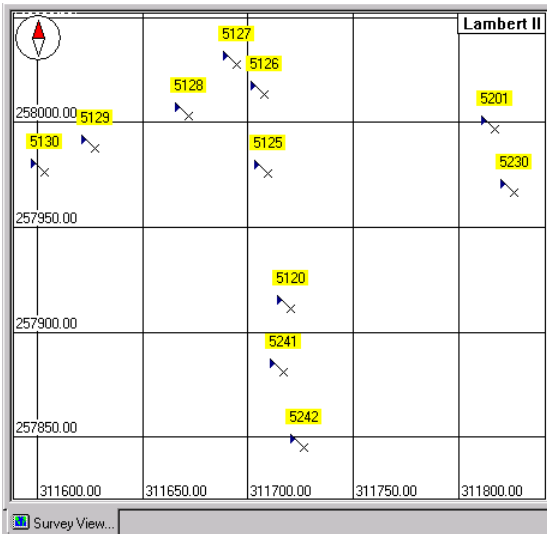


- Insert the 4SPack CD-ROM in the computer's CD drive
- Using the **Look in** combo box, select the following folder on the 4SPack CD-ROM: **..\Samples\Pcmcia**.

- Select the POINTS.txt file. This file contains all the target points for the project:



- Click **Open** to import the file to the project. As a result, all the target points contained in the imported file now appear on the View pane:



- The coordinates of these points can be viewed by opening the **Points (All coordinates)** document from the **Documents** tab in the Workspace pane:

	Name	East	North	Height	Status	Offset
1	S120	311720.090	257910.980	23.970	Set	No offset
2	S125	311709.260	257975.450	23.700	Set	No offset
3	S126	311707.500	258013.500	24.310	Set	No offset
4	S127	311694.630	258027.380	24.260	Set	No offset
5	S128	311671.970	258002.920	23.710	Set	No offset
6	S129	311627.590	257967.450	22.700	Set	No offset
7	S130	311603.280	257976.360	22.040	Set	No offset
8	S201	311817.510	257996.910	24.940	Set	No offset
9	S230	311826.450	257966.600	25.100	Set	No offset
10	S241	311716.800	257881.120	24.180	Set	No offset
11	S242	311726.820	257845.260	23.980	Set	No offset

Record 2

Survey Vie... Points (All Co...

□ Third Step: Uploading the Survey Job to the PC Card

(C:\Tmp folder emulates PC Card)

- On the 4SPack menu bar, select **Edit> Select All** or, on the map, drag a rectangle surrounding all the points
- Select **Project>Upload real-time Job**. This displays the **PCMCIA Transfer** dialog box. This box reminds you of the path to the PCMCIA emulation (C:\Temp)
- Click **OK**. The following dialog box then appears:

Upload Job To C:\temp

Transfer :

Selected Targets and References

Remaining Targets and References

All Targets and References

In order of :

Creation

As job : TUTO4_00

For operator :

OK

Cancel

- In this box, a default name is prompted for the job (TUTO4_00) derived from the project name (accept this name)
- Click **OK** to create the job (TUTO4_00.job) in the Temp folder.

❑ Fourth Step: Field Survey

(Skipped)

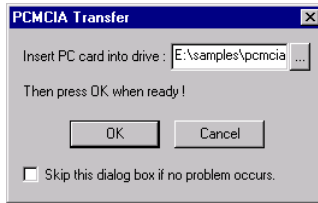
❑ Fifth Step: Downloading the Field Results

(\samples\pcmcia folder on 4SPack CD-ROM will emulate PC Card. This will allow you to retrieve the desired file, as if it were downloaded from a PCMCIA)

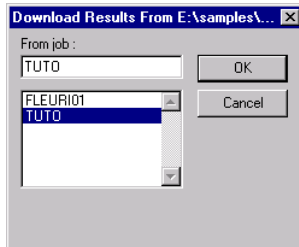
- Select **Project>Download real-time Results**. This displays the **PCMCIA Transfer** dialog box.
- In the **Insert PC card into drive** field, type the following:

<CD drive unit>\samples\pcmcia\

In the example below, <CD drive unit> = E:

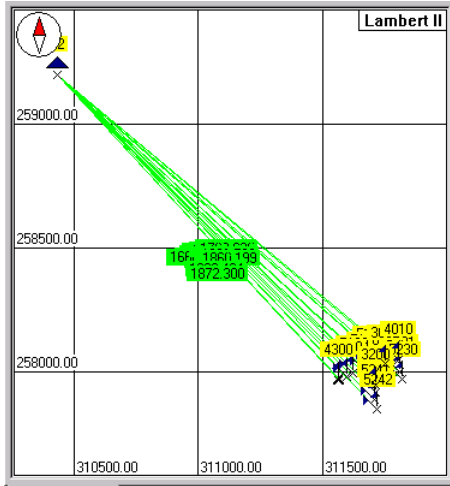


- Click **OK**. In the dialog box that appears, select TUTO. This file contains the results of the field survey (In fact we have made the survey for you):



- Click **OK**. This starts the download operation.

On completion of this operating phase, the map in the **Survey View...** document looks like this:



- Note that a new document called “TUTO” has been added to the document list on the **Documents** tab of the Workspace pane. This document is the results file in editable text format. It is stored in the project folder. Double-click on TUTO to open this document in the View pane:

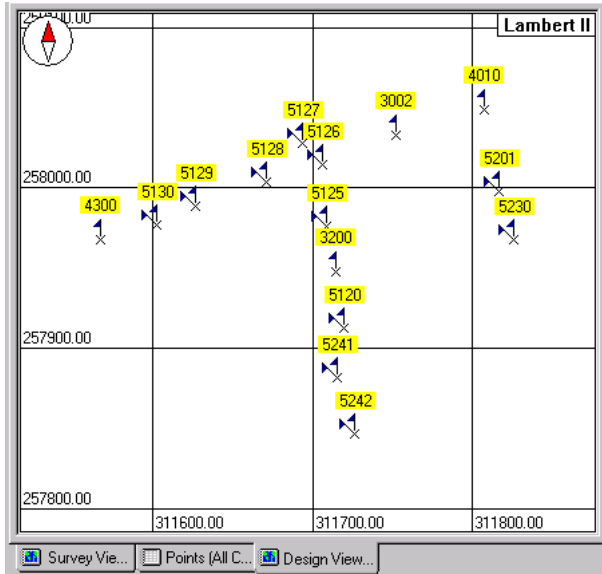
```

1 2 3 4 5 6 7 8 9 10 11 12
!L
*1,"27/03/02 16:45:10","John",""
*2,"tot",""
!!
!G
*1,1 "NTP"
*2,"A"6378249.200,"I"293.466021294,"S"1.000000000000,1
*3,"Dx"168.000,"Dy"60.000,"Dz"320.000,1
*4,"Ax"0.000000,"Ay"0.000000,"Az"0.000000,e
#1,02"Lambert 2",1

```

❑ Sixth Step: Comparing the Field Results with the Initial Target Points in the Job

- Open the **Design View** document. This document only shows points, not baselines
- Zoom in on the area where all the points are located.



This map shows the location of each surveyed target point (vertical flag+ leaning flag). The leaning flag is just to remind you that each of these points was initially planned in the project for staking out purposes (planned point).

- To have a closer look into the results, you can open the following documents on the View pane:
 - **Points (All Coordinates)** listing the type and coordinates of all the points of the survey. Additional points are shown that are not targets:
 - Logged points* (3200, 4300, 3002, 4010): additional points logged in the field that were not initially planned in the job
 - Station location* (S2)
 - Intermediate points* (4300_P1, 4300_P2, 4010_P1, 4010_P2): pivot points used to stake out an inaccessible point through one of the possible offset procedures (linear, lateral or intersection)
 - **Points (Target Coordinates)** listing only the coordinates of the target points as logged in the field while staking out these points
 - **Points (Station Coordinates)** providing the coordinates of the base station used in the field
 - **Points (Target Errors)** providing the deviations between planned and surveyed target points:

	Name	Control_Type	Horizontal_Error	Vertical_Error	Total_Error	
1	S120	3D control (Horizontal	1.002	0.002	1.002	Ste
2	S125	3D control (Horizontal	0.003	0.009	0.009	Ste
3	S126	3D control (Horizontal	0.008	0.003	0.009	Ste
4	S127	3D control (Horizontal	0.005	0.008	0.009	Ste
5	S128	3D control (Horizontal	0.005	0.003	0.006	Ste
6	S129	3D control (Horizontal	0.002	0.007	0.007	Ste
7	S130	3D control (Horizontal	0.005	0.004	0.006	Ste
8	S201	3D control (Horizontal	0.004	0.004	0.006	Ste
9	S230	3D control (Horizontal	0.006	0.014	0.016	Ste
10	S241	3D control (Horizontal	0.009	0.008	0.012	Ste
11	S242	3D control (Horizontal	0.004	0.003	0.005	Ste

Record | 0

Survey Vie... Design Vie... Points (All C... Points (Targ... Points (Targ... Points (Stati...

- Select **File>Close Workspace**. This saves and closes the project contained in the workspace, and the workspace as well.

Real-Time Project: Determining a Local Grid

In this example, we will determine a new coordinate system (local grid) starting from a number of surveyed target points used as references.

The target points are provided in the form of a real-time results file that we will download into an empty project using an “unknown” coordinate system.

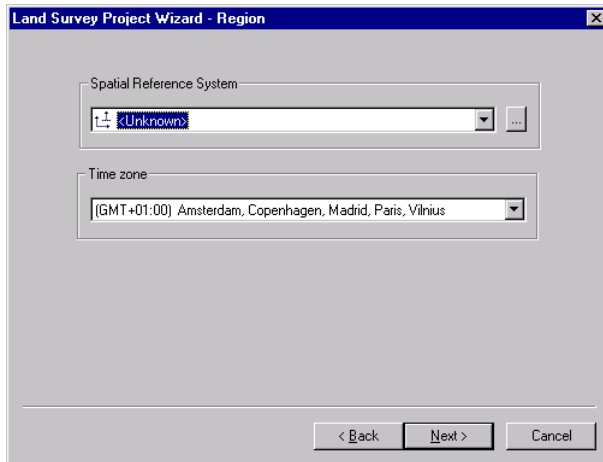
In the fourth step, we will examine the characteristics of the local grid determined by 4SPack, which incidentally will allow us to introduce the way 4SPack manages its library of coordinate systems. It is worth noting that 4SPack strictly complies with the OpenGIS Implementation Specification document concerning coordinate transformations.

Finally, in the last two steps, we will introduce the Report Generation function offering an easy way of producing ready-to-use survey reports.

□ First Step: Creating a New Project

- On the 4SPack menu bar, select **File>New**
- In the **New** dialog box that appears, select the **Projects** tab (unless already done)
- In this tab, select **Land Survey Project** on the left
- In the Project name edit box, type a name for the new project. For example, type **Tuto5_process**
- Click **OK**. In the **Welcome** dialog box that appears, check the **By entering all settings** check box
- Click **Next**. In the new dialog box that appears, select **Unknown** as the spatial reference system to be used in the new project.

Keep the default selection in the **Time zone** field (GMT+01:00):



- Click **Next** three times.
- In the **Transfer** tab, check the 6000 receiver option allowing data exchange with a PC card (PCMCIA).
Leave all the other settings unchanged.
- Click **Finish** to allow 4SPack to create the new project. After 4SPack has created the new project, note the following warnings reported on the Output pane:

```
New Land Survey Project "Tuto5_Process" !
Creating Project Database... Ok
Creating System Collections... Ok
ERROR : Failed to load data for layer "Adjusted Vectors" !
ERROR : Failed to load data for layer "Fixed Vectors" !
ERROR : Failed to load data for layer "Unfixed Vectors" !
ERROR : Failed to load data for layer "Processes" !
```

As reported in the Output pane, all objects from collections cannot be viewed on the default map document, as the latter uses the same coordinate system as the project, namely an "Unknown" system.

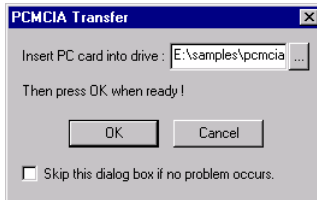
❑ Second Step: Downloading the Real-Time Results containing the Surveyed Points

(\samples\pcmcia folder on 4SPack CD-ROM will emulate PC Card. This will allow us to retrieve the desired file, as if it were downloaded from a PCMCIA)

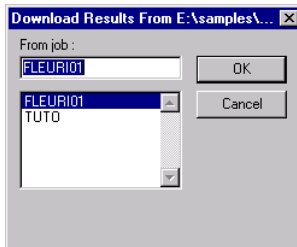
- Select **Project>Download real-time Results**. This displays the **PCMCIA Transfer** dialog box.
- In the **Insert PC card into drive** field, type the following:

<CD drive unit>\samples\pcmcia\

In the example below, <CD drive unit> = E:

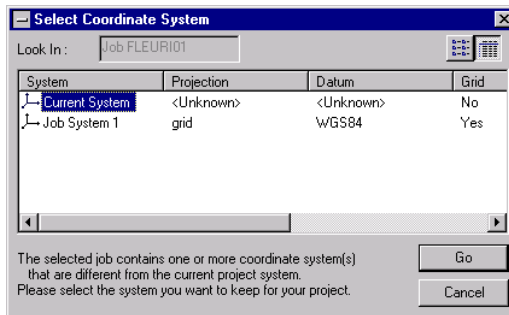


- Click **OK**. In the dialog box that appears, select **FLEURI01**. This file contains the results of the field survey (In fact we have made the survey for you):



- Click **OK**. This starts the download operation.

4SPack then asks which coordinate system to use in the project as 4SPack has detected that the selected results file refers to another coordinate system. Choose “Current System”:




- Then, click **Go** to download the FLEURI01 file. On completion of the download operation, note that the project map remains blank as 4SPack is still unable to reliably locate any points on the map (“Unknown” displayed in the right-upper corner of the map).

The following message lines appear on the Output pane:

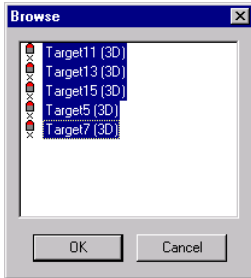
```
Warning : According to transfer option 2, new reference point Target7 has been created !
Warning : According to transfer option 2, new reference point Target5 has been created !
Warning : According to transfer option 2, new reference point Target15 has been created !
Warning : According to transfer option 2, new reference point Target13 has been created !
Warning : According to transfer option 2, new reference point Target11 has been created !
```

These warnings refer to the Transfer options in the **Project Settings** dialog box (access: **Project>Edit Settings...**, **Transfer** tab).

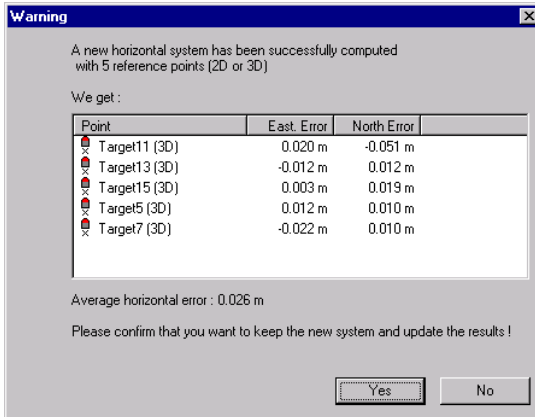
To display option 2 on this tab, in the **When reading results...** area, click  once to display the setting of this option.

❑ Third Step: Computing the Horizontal Grid

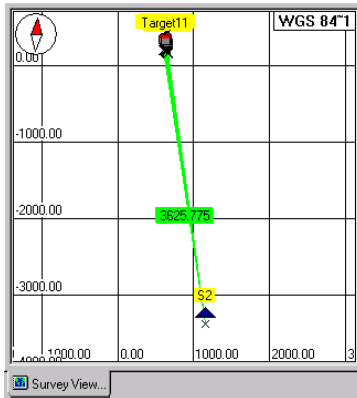
- On the 4SPack menu bar, select **Project>Compute Horizontal Grid...**
This opens the **Compute Local Grid** dialog box
- Click the **Add** button
- In the **Browse** dialog box that opens, select all the targets (using the Shift key):



- Click **OK**
- Click **OK** in the **Compute Local Grid** dialog box. This starts the horizontal grid computation. On completion of this processing phase, the following **Warning** dialog box is displayed:




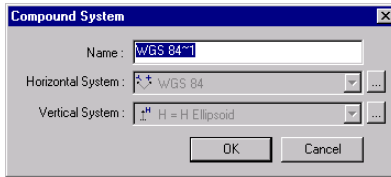
- Click **Yes** to confirm that you wish to use the horizontal grid that 4SPack has just determined.
- After this, the **Survey View** document is as follows:




Note that “WGS84~1” is displayed in the right-upper corner of the view. This name has automatically been assigned to the newly determined spatial reference system.

❑ Fourth Step: Displaying the Characteristics of the New Spatial Reference System

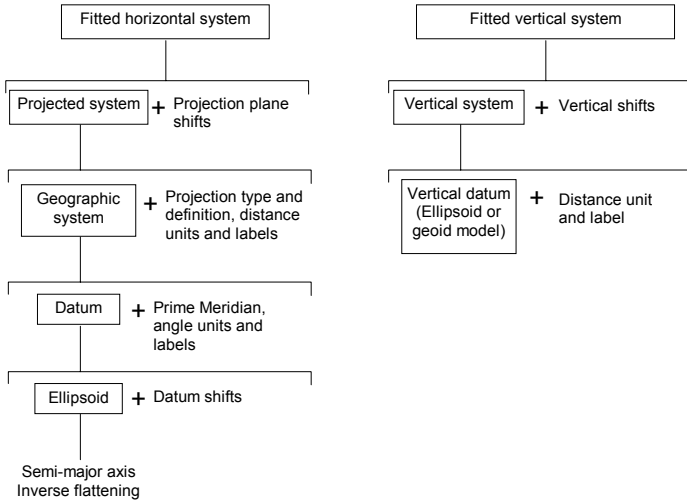
- On the 4SPack menu bar, select **Project> Edit Settings...** This opens the **Project Settings** dialog box
- Unless already done, select the **Region** tab. As expected, the spatial reference system now used in the project is “WGS84*1”
- Click  opposite the **Spatial Reference System** field. A new dialog box opens showing the definition of the new system (see below). Basically this is a compound system consisting of a horizontal system and a vertical system:



In this dialog box, you can change the default name (WGS84*1) for a name of your choice (if desirable).

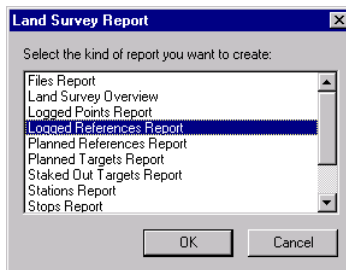
- Using the  buttons attached to each field, you can scroll up and down in the definitions of the horizontal and vertical systems.

The two diagrams below summarize the architecture of each of these systems (general cases).



□ Fifth Step: Generating a Report

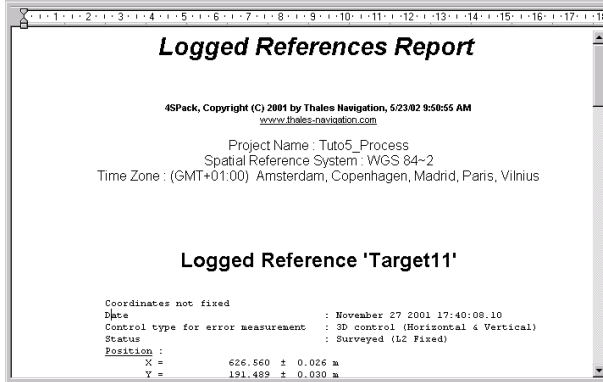
- On the 4SPack menu bar, select **Project>Generate Report...**
- In the dialog box that opens, select **Logged Reference Points** in the list of possible reports



- Click **OK** to let 4SPack generate the report (based on an internal template).

The report then appears on the View pane, as if it were one of the documents opened from the **Documents** tab.

- Use the vertical scroll bar on the right to scroll up and down in the report. The beginning of the report looks like this:



□ Sixth Step: Editing and Saving the Report

- If necessary, make changes to the report content or layout using the toolbar now displayed under the 4SPack menu bar. You can also edit text directly in the report, as you would do with any text editor or office software.
- When you are satisfied with the content and aspect of the report, on the 4SPack menu bar, select **File>Save report...** or **File >Save report As...** to save the report.

If you select **File>Save report...** the report will be saved in the current project folder under the default name “Logged References Report.rtf”. If you select **File >Save report As...** a **Save As** dialog box will open and you will then be allowed to choose the folder where to save the file and the name under which you wish to save the file. In both cases however, the file produced will necessarily be an “rtf” (rich text format) file.

- Select **File>Close Workspace**. This saves and closes the project contained in the workspace, and the workspace as well.

Introducing Background Map Projects

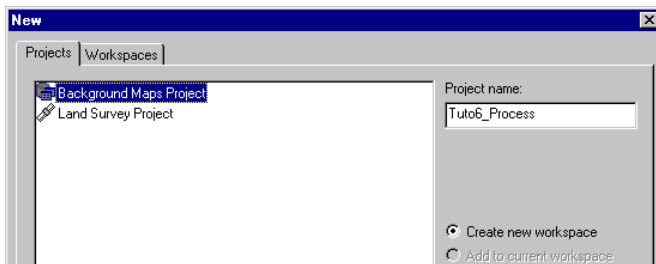
Background map projects can accompany your land survey projects enriching them with diverse categories of information. Associating a background map project with a land survey project is simply made by creating the two projects in the same workspace. Obviously, the two projects must cover the same geographic area.

With this example, you will become familiar with the architecture of a background map project. Incidentally, you will also learn that you can drag and drop any collection from the workspace pane to any document open on the View pane. This technique for inserting data into a document is really simple and in addition can be used in both types of projects.

❑ First Step: Creating a New Project

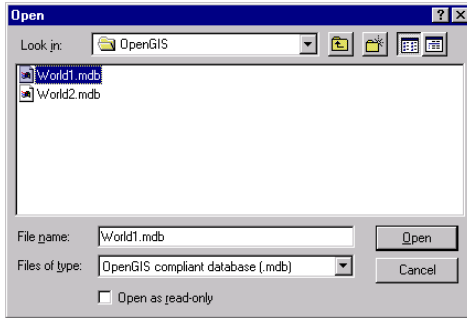
① In this step, you will have to insert the 4SPack installation CD-ROM in the computer's CD drive.

- Insert the 4SPack CD-ROM in the computer's CD drive
- On the 4SPack menu bar, select **File>New**
- In the **New** dialog box that appears, unless already done, select the **Projects** tab
- In this tab, select **Background Maps Project** on the left
- In the Project name edit box, type a name for the new project. For example, type **Tuto6_process**



- Click **OK**. This causes an **Open** dialog box to open


- Using the **Look in** combo box in the **Open** dialog box, select the following folder on the 4SPack CD-ROM: ..\Samples\OpenGIS and select the file “World1.mdb”:

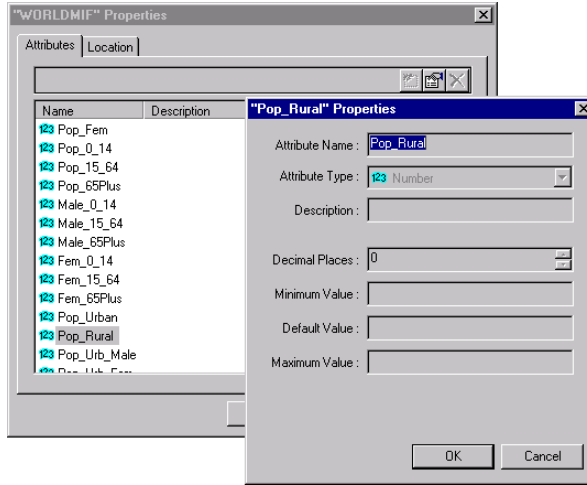


- Click **Open**. This enables 4SPack to create the new project.

□ **Second Step: Analyzing the Content of the Project**


- Once the project is created, select the **Collections** tab in the Work-space pane and select the single collection present in the project, named “WORLDMIF”
- On the 4SPack menu bar, select **View>Properties**. The dialog box that opens displays the properties of the WORLDMIF collection, which are two types:
 - Attributes
 - Location
- Select the **Attributes** tab

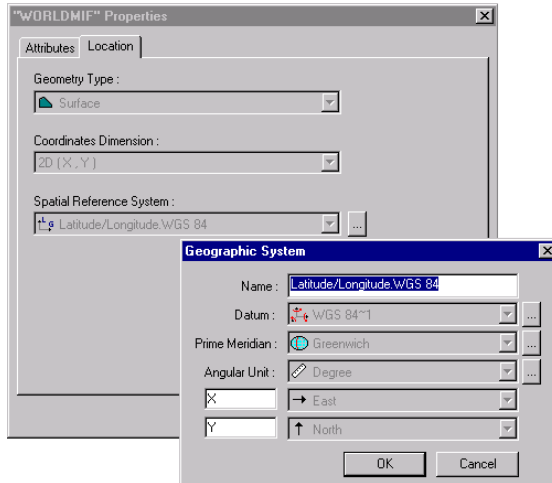
- Select any of these items in the list and then click  located on the right to display the properties of this item in another secondary window (no changes allowed in this box):



Each of the listed items has its own properties that you can display as explained in the previous point.

- Click **OK** to close the window last open and then select the **Location** tab on the "WORLDIMF" Properties dialog box. This tab indicates the geometric properties of the collection which fall into three categories:
 - Geometry type (area)
 - Coordinates dimension (2D)
 - Spatial Reference System used

- Click  opposite the **Spatial Reference System** field to access the definition of the spatial reference system on which the collection relies:

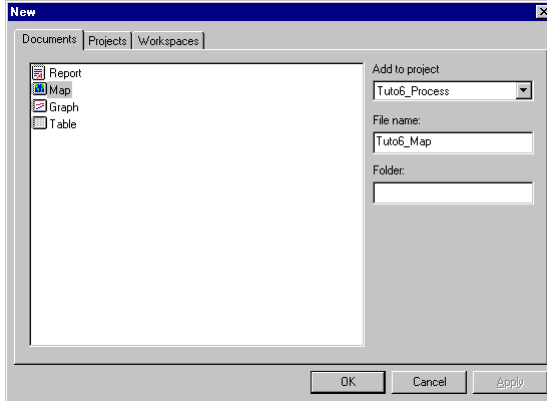


As you can see the spatial reference system is defined using the same architecture as the one presented in the previous example (see page 56).

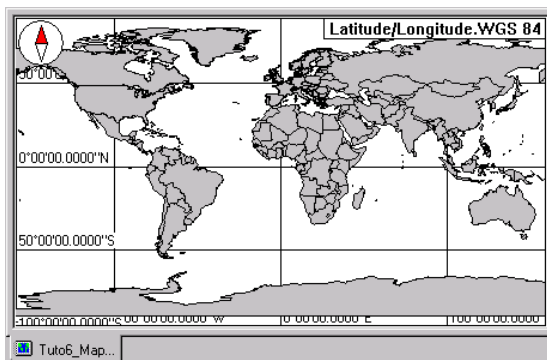
- Click **OK** to close the window last open and then **OK** again to close the **"WORLD MIF" Properties** dialog box.

□ Third Step: Creating a Map document in the Project

- On the 4SPack menu bar, select **File>New**. In the **New** dialog box, select the **Documents** tab. Then select **Map** in the list on the left and type a name in the **File name** edit box (for example: Tuto6_Map):

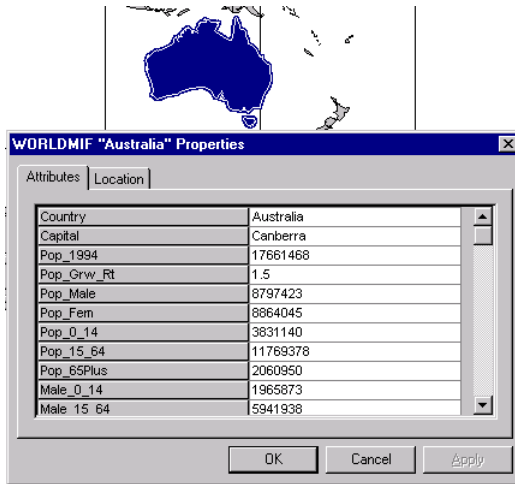


- Click **OK**. A new, empty, map document then opens on the View pane.
- From the **Collections** tab of the Workspace pane, drag and drop the **WORLDMIF** collection on the map document. As a result, the following appears in the map document:



❑ Fourth Step: Working on the Map


- For example zoom-in on Australia using the usual tools on the Map toolbar
- Using the Select tool on the same toolbar, select this country on the map
- Right-click on the mouse (keeping the cursor over Australia) and then select **Properties** on the pop-up menu.




As you can see, the project provides a lot of details about this object shown on the map. This is true for any other country that you can select on the map.

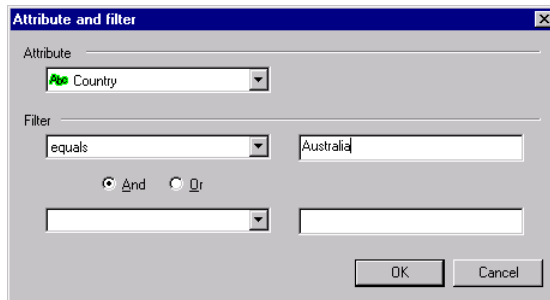
On the **Location** tab, the project also provides the coordinates of all the points used to draw the country borders on the map as well as the identification of the spatial reference system used to express these coordinates.

- Click **OK** to close this **Properties** dialog box

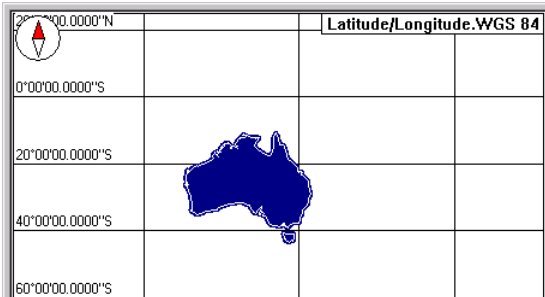
- Right-click on the map document and select **Legend** in the pop-up menu
- Click  in the right-upper part of the window that displays to edit the legend. A new **Properties** dialog box opens.

On the **Style** tab, you can define the color and borderline for each object on the map. This choice applies to ALL objects on the map.

On the **Data** tab, after clicking , you can set a filter on the map. For example, after setting the following filter:



And after you click **OK** three times to close all the legend-related dialog boxes, you will get the following in the map document:



□ Fifth Step: Creating a Table Document in the Project

- On the 4SPack menu bar, select **File>New**. In the **New** dialog box that opens, select the **Documents** tab. Then select **Table** in the list on the left and type a name in the **File name** edit box (for example: Tuto6_Table)
- Click **OK**. A new, empty, table document then opens on the View pane.
- From the **Collections** tab of the Workspace pane, drag and drop the **WORLDMIF** collection on the table document. As a result, the following appears in the table document:

	Country	Capital	Pop_1994	Pop_Grw_Rt
1	Belarus	Minsk	10222649	0.4
2	Poland	Warsaw	38309226	0.1
3	Zimbabwe	Harare	8687327	2.9
4	Zambia	Lusaka	7818447	3.5
5	Zaire	Kinshasa	30981382	3.3
6	Yugoslavia	Belgrade	10394026	0.6
7	Yemen	Sanaa	12301970	3.2
8	Western Samoa	Apia	156349	2.3
9	Western Sahara	N/A	76425	2.6
10	Vietnam	Hanoi	64375762	2.1
11	Venezuela	Caracas	20248826	2.4
12	Vatican City (holy See)	Vatican City	1000	0
13	Vanuatu	Port-vila	150165	3.1

Record: 0

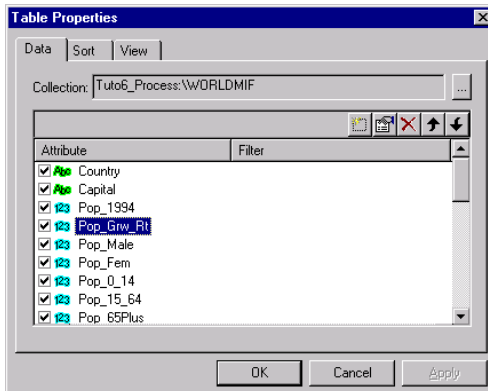
Tuto6_Map... Tuto_Table...


❑ Sixth Step: Sorting / Filtering Data

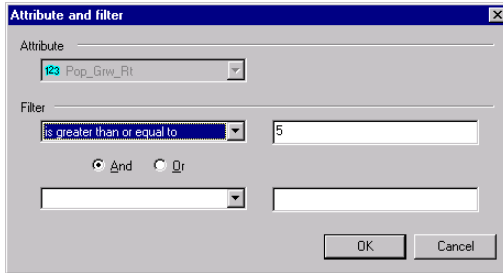
- On the 4SPack menu bar, select **Table>Sort**
- In the **Table Properties** dialog box that opens, select “Country” in the first **Order by** combo box
- Click **OK**. As a result, the table content is re-arranged to show the data rows in ascending order of country names (sort criterion: country name in **Country** column):

	Country	Capital	Pop_1994	Pop_Grw_Rt
21	Belgium	Brussels	9967378	0.1
22	Belize	Belmopan	205000	3.6
23	Benin	Porto-Novo	4304000	3.3
24	Bermuda	Hamilton	61220	1.5
25	Bhutan	Thimphu	1596000	2
26	Bolivia	La Paz	6420792	2.4
27	Bosnia And Herzegovina	Sarajevo	3707000	0
28	Botswana	Gaborone	1326796	2.7
29	Brazil	Brasilia	150367000	1.6
30	British Virgin Islands	Road Town	18000	1.1
31	Brunei Darussalam	Bandar Seri Begawan	267800	6.3
32	Bulgaria	Sofia	8990741	-0.2
33	Burkina Faso	Ouagadougou	9190791	3.1

- On the 4SPack menu bar, select **Table>Data**
- In the **Table Properties** dialog box that opens, select “Pop_Grw_Rt” in the attribute list:



- Click  to open the **Attribute and Filter** dialog box
- Make the following choices in this box.



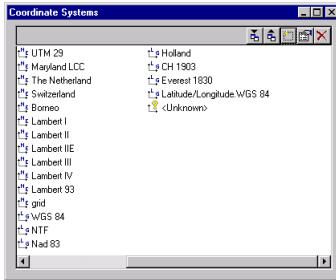
- Click **OK**
- Click **OK** to close the **Table Properties** dialog box. As a result, the table document only lists those countries for which the population growth rate is greater than 5%, as requested by the above filter.

	Country	Capital	Pop_1994	Pop_Grw_Rt
▽				>=5
1	Afghanistan	Kabul	15513267	5.2
2	Brunei Darussalam	Bandar Seri Begawan	267800	6.3
3	Qatar	Doha	369079	5.3
4	United Arab Emirates	Abu Dhabi	862000	5.7

End of the example. Select **File>Close Workspace...** to save and close the project and the workspace.

Creating a New Coordinate System

In this section, you will learn how to create a new coordinate system. You do not need to open a project to do this. On the 4SPack menu bar, select **Tools>Coordinate Systems...** . This opens the **Coordinate Systems** dialog box listing all the coordinate systems stored in 4SPack, and from which you can create a new system. Example of dialog box then displayed:




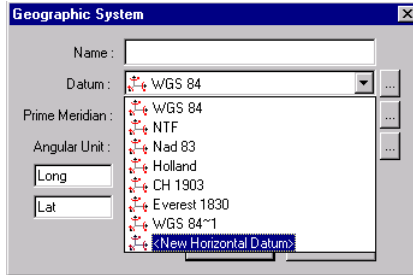
Assuming you want to create the following system:

Name: United Kingdom
 Central Meridian: 2°W
 Scale Factor: 0.99960127
 Latitude at origin: 49.00°N
 Eo: 400 000.000, No: -100 000.000
 Projection Type: Transverse Mercator
 Datum: Name: OSGB36
 Dx: 375.000
 Dy: -111.000
 Dz: 431.000
 $\alpha_x = \alpha_y = \alpha_z = 0.0^\circ$
 Scale Factor: 1.000
 Ellipsoid: Name: AIRY
 Semi-major axis: 6377563.396
 Inverse flattening: 299.324964578

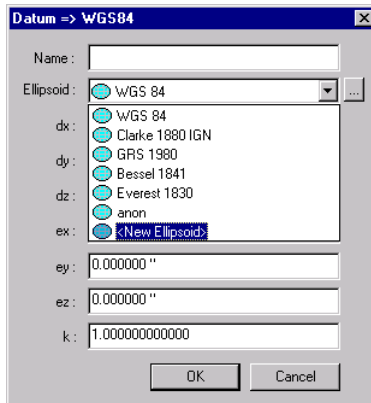
The creation process will go through two different steps: first you will have to create a geographic system in which you will define the required ellipsoid and datum. Then you will have to create a projected system in which you will introduce the required projection placed over the previous geographic system.

❑ First Step: Creating the Geographic System

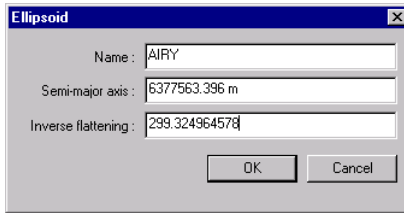
- Click  and select **2D System>Geographic...**
- In the **Datum** combo box, select **<New Horizontal Datum>**:



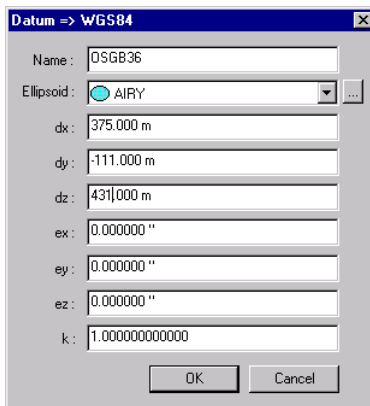
- In the new dialog box that opens, click on the **Ellipsoid** combo box and choose **<New ellipsoid>**:



- In the new dialog box that opens, enter the definition of the new ellipsoid, as indicated below:



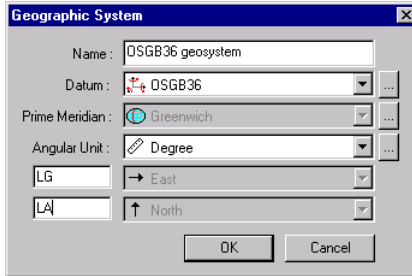
- Click **OK**. This closes the above dialog box. The name of the new ellipsoid now appears in the active dialog box. In this box, type the characteristics of the OSGB36 datum (name and shifts), as shown below:



- Click **OK**. This closes the above dialog box. The name of the new datum now appears in the active dialog box.


In this box, you create a new “layer” –just one step above the datum level and called “geographic system”– in which you associate labels for coordinates and an angle unit to the datum you have just defined. **It is therefore important to define a slightly different name for the geographic system to avoid confusion between these two definition levels.**

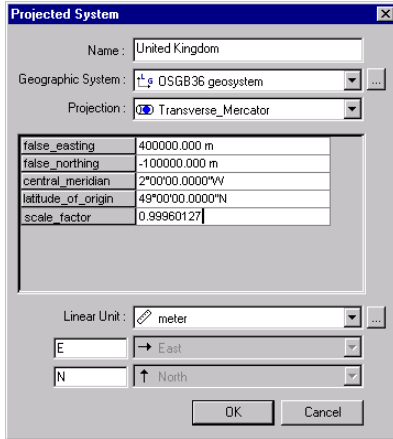
- For example, name the geographic system based on OSGB36 as follows and define the following labels and angle unit:



- Click **OK**. This closes the active window and takes you back to the **Coordinate Systems** dialog box. The list now includes the new geographic system you have just created.

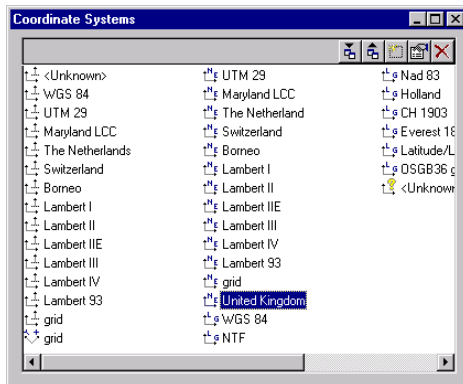
❑ Second Step: Creating a Projected System

- Click  and select **2D System>Projected...**
- In the dialog box that opens, enter the following:



- Click **OK**. This closes the active window and takes you back to the **Coordinate Systems** dialog box.

The list now includes the new projected system you have just created:



3. 4SPack Functions

This section provides detailed information on all the functions available in 4SPack. To try to be as exhaustive as possible, we will first provide a brief description of all the commands available from the 4SPack menu bar. Second, we will present in more detail some of the 4SPack features not described elsewhere in the manual.

File Menu

- New:** Opens the **New** dialog box to create a document, workspace or project
- Close xxx:** Closes the active document (xxx: table, graph, report or map)
- Save xxx As...:** Saves the active document (xxx: table, graph, report or map)
- Open Workspace...:** Opens the workspace that you choose in the list of workspaces. If a workspace is already open in 4SPack, this workspace will be closed before opening the selected one
- Close Workspace:** Closes the currently open workspace. Saves the workspace and its project(s) before closing them all
- Print xxx...:** Prints the active document (xxx: table, graph, report or map)
- Print Preview:** Previews the active document to see what it will look like when printed
- Print Setup...:** Opens the **Print Setup** dialog box to choose printer settings
- Recent Workspaces:** Lists the 4 workspaces last open. Selecting one in the list closes the currently open workspace and opens the selected one
- Exit:** Exits 4SPack

Edit Menu

- Undo:** Undoes the last action performed (unless it is a delete or add action)
- Redo:** Cancels the last Undo action performed
- Cut:** Cuts the current selection to the clipboard
- Copy:** Copies the current selection to the clipboard
- Paste:** Pastes the data from the clipboard at the insertion point
- Delete:** Deletes the document currently selected in the **Documents** tab, or the object currently selected in the active map document
- Rename:** Renames the document currently selected in **Documents** tab
- Select All:** (Insertion point must be in an open report document) Selects the entire document
- Insert New Object:** Prompts you to enter a new object into the active report, at the insertion point
- Links...:** For an object selected in the active report, shows the definition of the link through which this object is present in the report (in the case of an object inserted into the report by reference)
- Objects:** Edits the selected object in the active report document.

View Menu

- As Workbook:** Configures the View pane as a workbook, i.e. with tabs in the lower part providing easy access to any open document
- Workspace:** Shows/hides the workspace pane

- Output:** Shows/hides the output pane
- Ruler:** Shows/hides the ruler on top of the active report document
- Refresh:** Refreshes the content of the open map document
- Properties:** Shows the properties of the selected collection

Table Menu

(Available only if a table document is active in the View pane.)

- Data:** Provides access to the **Data** tab in the **Table Properties** dialog box. Used to remove, re-arrange, restore and filter the attributes present in a table document. The types of attributes shown in a table document come from a given collection.
- Sort:** Provides access to the **Sort** tab in the **Table Properties** dialog box. Allows you to list the rows of attributes according to your criteria.
- View:** Provides access to the **View** tab in the **Table Properties** dialog box. Shows the spatial reference system and the time zone attached to the table document.

Report Menu

(Available only if a report document is active in the View pane.)

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

Graph Menu

(Available only if a graph document is active in the View pane.)

- Legend:** Provides access to the **Legend** tab in the **Graph Properties** dialog box.
- View:** Provides access to the **View** tab in the **Graph Properties** dialog box. Shows the spatial reference system and the time zone attached to the graph document. Also lets you define a title for the graph. The title will then appear above the graph in the document.
- Zoom out:** Restores the normal (non-magnified) graph in the active graph document.

Map Menu

(Available only if a map document is active in the View pane.)

- Select:** 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
- Zoom In:** Zooms in on the area where you click or drag
- Zoom Out:** Zooms out from where you click or drag
- Zoom To Fit:** Adjusts the map scale so that all the visible objects present on the map can be seen
- Grabber:** Shifts the map as instructed. The map shift directly proceeds from the length and orientation of the segment you drag on the map

- Distance:** Measures the distance between two points that you draw 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
- Set Active Collection:** Allows you to choose the type of object you want to place on the map, equivalent to using the combo box on the Map toolbar
- Draw Points:** Allows you to add a point on the map
- Draw Lines:** Allows you to add a line on the map
- Draw Areas:** Allows you to add an area on the map
- Ruler:** Shows/hides the coordinates on the map
- Grid:** Shows/hides the grid on the map
- Legend:** Provides access to the **Map Properties** dialog box, **Legend** tab. This tab allows you to choose the objects you want to show or hide on the map. You can also define the visual aspect that 4SPack must give to each type of object (color, icon, shape, label, etc.)
- View:** Provides access to the **Map Properties** dialog box, **View** tab. This tab indicates the coordinates of the map's current central point, the scale currently used, the name of the coordinate system (Spatial Reference System) used and the current settings for the map viewing options (grid and ruler)

Project Menu

- Set Active Project:** Allows you to choose which project must be active (you have to make this choice if there is more than one project in the workspace)
- Import Data From Files...:** Allows you to import different types of data to the project database. Each type may be in various formats:
- Points (NMEA or custom)
 - Vectors (custom)
 - Raw data (SBIN, SVAR, SFIX, proprietary formats)
- Export Data to Files...:** Allows you to export different types of data to a file. Each type may be in various formats:
- Points (NMEA or custom)
 - Vectors (custom)
- Group Points...:** Transforms the selected points in the active map document as a line or an area. The points involved in this operation may be deleted or kept unchanged.
- Ungroup Points...:** Creates separate, independent points from the points forming the selected line or area. The selected line or area can be kept unchanged or deleted.
- Change Into...:** Used to change the type of the point currently selected in the active map document
- Upload real-time Job...:** Used to transfer a job to the field equipment in order to assist the operator in his/her real-time survey

- Download real-time Results:** Used to transfer the results files of a real-time survey, once complete, to 4SPack for further analysis
- Process Single Site...:** Used to compute an averaged position solution for the selected site using the field observations available for this site
- Build Process Scenario...:** Examines or re-examines all the observation files available in the project to deduce all the possible baselines that can be processed, making assumptions on which points are reference points and which ones are not. This command is automatically run following data import so that you can directly run the **Process Baselines...** command
- Process Baselines...:** Processes all or some of the baselines reported in the scenario (see previous command). The result of each processed baseline is a vector
- Adjust Baselines...:** Runs network adjustment processing on the vectors resulting from the previous command. The purpose is to issue a single solution for every surveyed point
- Compute Datum Shifts...:** Computes the datum shifts based on the reference points that you specify
- Compute Horizontal Grid...:** Computes the characteristics of a horizontal grid based on the reference points that you specify
- Compute Vertical Correction...:** Computes the characteristics of a vertical correction based on the reference points that you specify
- Generate Report...:** Automatically generates a pre-formatted report in RTF format after you choose the type of data for which you want a report to be created

Edit Settings...: Opens the **Project Settings** dialog box containing four different tabs. The project's coordinate system and time zone are defined on the **Region** tab. The operators' list for the active project is defined on the **Operators** tab. The geocodes, and corresponding meanings, that can be associated with the points of the active project are defined on the **Geocodes** tab. The **Transfer** tab is used to define the type of survey equipment used in conjunction with 4SPack and the associated data exchange means (PCMCIA or serial port). It is also used to set a number of processing choices that 4SPack will need when you download field data.

Insert Project Into Worksp...: Allows you to add a project from another workspace to the currently open workspace. In fact, it is still the same single project, but seen from another workspace. If for example you make changes to this project, these changes will also appear when you open this project in the original workspace. 4SPack can only open a single workspace at a time.

Tools Menu

- Geoids:** Launches the Geoids utility in a separate window (see Section 9)
- Coordinate Systems...:** Provides access to the library of coordinate systems created in 4SPack. Window fitted with powerful import, export, add, edit and delete functions.
- Test Transfo...:** Launches a utility used to test coordinate transformations in a separate window. 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.
- Leap Seconds...:** Lets you edit/add/delete leap seconds for any given date
- 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
- Customize...:** Opens the **Customize** dialog box containing three tabs. The **Toolbars** tab lets you choose which default toolbars to display in the 4SPack window. Other viewing options can be set on this tab. The **Command** tab lets you move the available 4SPack command buttons to any toolbar. The **Tools** tab is used to add/remove new programs to the 4SPack Tools menu.
- Options...:** Opens the **Options** dialog box in which you can set a number of editing options concerning report documents

Window Menu

- Cascade:** Arranges the open documents in cascade configuration
- Tile Horizontally:** Arranges the open documents in horizontal tile configuration
- Tile Vertically:** Arranges the open documents in vertical tile configuration
- Close All:** Closes all the documents open in the View pane
- {Open Documents List}:** Lists all the documents open in the View pane. Checking one of them makes it the active document.

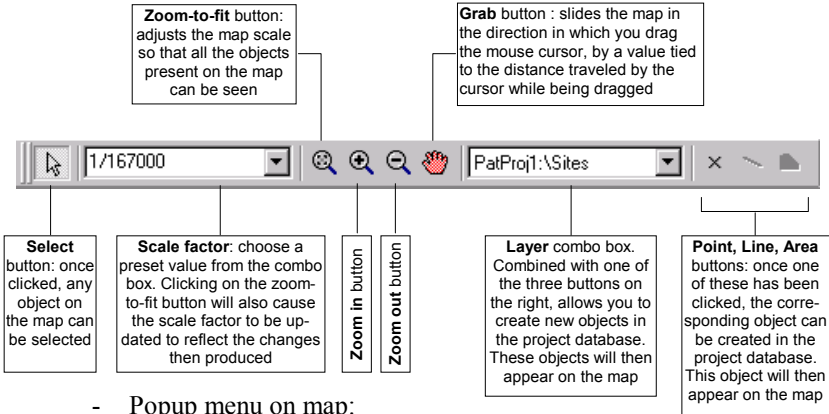
? Menu

- User's Guide:** Opens the electronic User's guide in Acrobat Reader
- Explain:** Not implemented
- About 4SPack...:** Displays the software version, licensee name and list of installed software applications. Provides access to another dialog box allowing you to unlock software options after getting a password from Thales Navigation. The password is tied to a personal code deduced from the computer hardware.

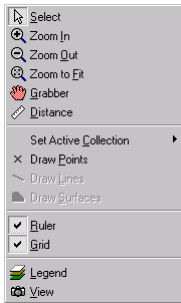
Working in a Map Document

The following tools are available to work in a map document:

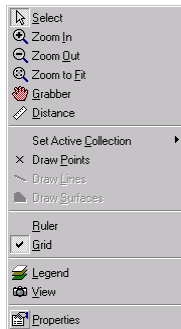
- Toolbar:



- Popup menu on map:



- Map menu from menu bar:




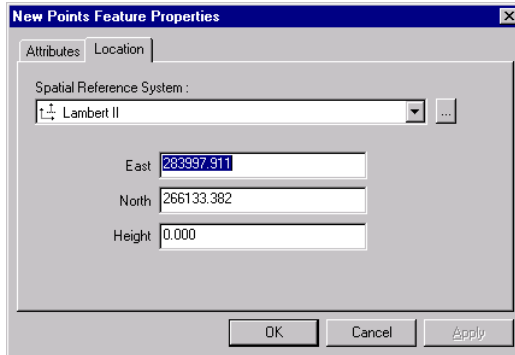
□ Adding an object to a collection from the map

For example, open the Tuto2_Process project created in the Tutorials section. Follow the instructions below to create a new reference point in this project. The point will be named “LandMark#10”.

- On the Map toolbar, in the combo box located on the right, select **<Project_Name> \ Points**:

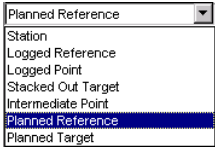


- On the Map toolbar, click 
- Move the mouse cursor over the map and left-click where you want to create a new point. A new dialog box opens showing the coordinates of the new point resulting from where you clicked on the map. This dialog box shows the coordinates of the point in the project's spatial reference system. Example:

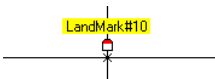


- If this point is accurately known, you may need to enter its coordinates to be exactly those known for the point

- Select the **Attributes** tab. In the first field, type a name for the new point. In the second field (a combo box), choose the type of point you are creating. Example:





- Click **OK**. The new point now appears on the map. Its representation on the map relies on the definition of a *layer* that is associated with the type this point belongs to. We will come back to this particular point in the next two paragraphs. Example of point representation:



You can quickly create as many points as required having the same type as this one by holding down the **Shift** key and clicking repeatedly on the map where you want these points to be created. In this case, 4SPack skips the display of the **New Points Feature Properties** dialog box and directly creates the points.

Lines & areas can be created using the same technique. On the map toolbar:

- Select **<Project_Name> \ Lines** in the combo box, click , then start drawing the line on the map. Click on the start point, then at the end of each new segment forming the line. To end the line, make a double click. In the dialog box that opens, the **Location** tab shows the coordinates of the points where segments end or start. The line attributes shown on the **Attributes** tab only consist of 4 possible geocodes plus a comment field.
- Select **<Project_Name> \ Areas** in the combo box, click , then start drawing the limits of the area. Click on the start point, then at the end of each new segment forming the area. Make a double click on the map to close the area. If you double-click on a point other than the area's start point, 4SPack will automatically create the missing segment allowing it to close the geometric figure. In the dialog box that opens, the **Location** tab shows the coordinates of the points where segments end or start. The area attributes shown on the **Attributes** tab only consist of 4 possible geocodes plus a comment field.

□ **Showing/hiding a collection on the map**

- On the map pop-up menu, select **Legend**. This dialog box provides the list of existing layers. If the button opposite is checked, then all the objects from a collection meeting the criteria of this layer (see below) will be visible on the map. On the contrary, if this button is cleared, none of these objects will appear on the map.


□ Adding a new layer on the map

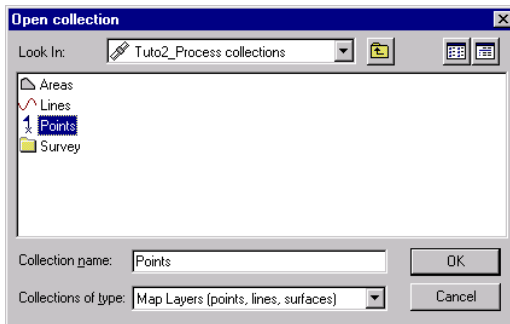
As explained earlier, representing any object from a collection in the project database resorts to the use of a *layer*. In any project that you create, there is a number of default layers created by 4SPack itself. However you can create as many layers as necessary for a given collection. For example, 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:

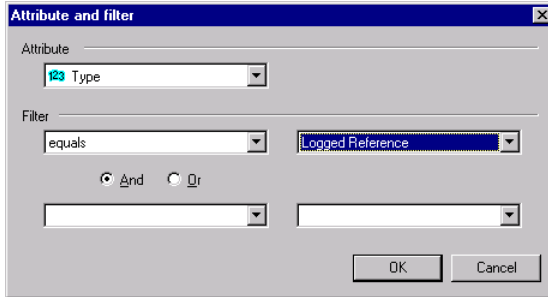
1. Choose the collection on which the layer will apply to
2. Name the layer
3. Define a filter on the attributes of the source collection. In fact, the definition of the layer will result from the choices you make in this step
4. Define a style (icon and associated text) specific to the layer. 4SPack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

In the example below we will create a new layer called “Reference Points” corresponding to any object from the Points collection for which Type=Reference Points. This will be done using the Tuto2_Process project that we created in the Tutorial section.

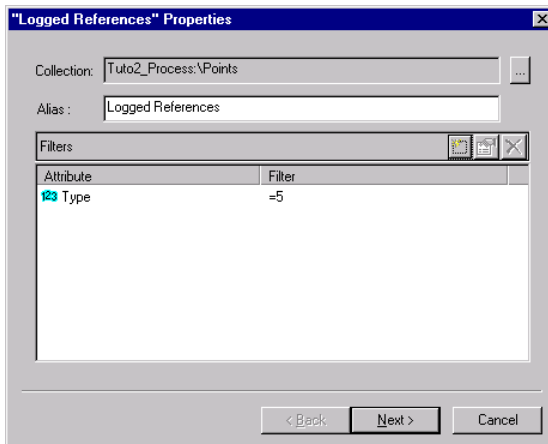
- On the menu bar, select **Map>Legend**
- On the **Legend** tab, click 
- In the new dialog box that opens, select “Points”:



- Click **OK**. In the **Layer Wizard: Data** dialog box that opens, type a name for the new layer in the **Alias** field. For example, type “Logged References”
- Then click  on the right
- In the new dialog box that opens, set the attribute filter as shown in the screen capture below:



- Click **OK**. A new dialog box shows the filter settings you have just made:



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

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)

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

Use these buttons to adjust the size of the object on the map

Check this button to see what the object looks like when selected

This area is constantly updated to show the aspect of the object as you define the style

Layer Wizard : Style

Text Name

Back

Symbol [rectangle]

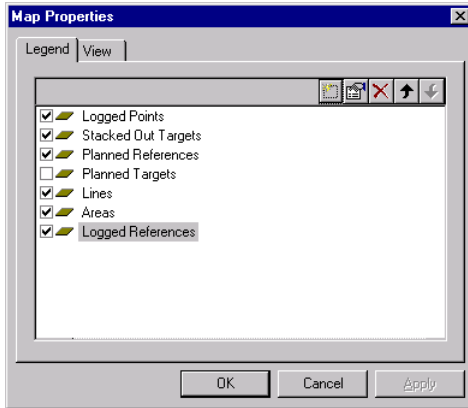
Line

Fill





Normal Selected

< Back Finish Cancel

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



Incidentally, 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
 -  to move the selected layer downward in the list
- Click **OK** to close the dialog box. The map is updated to take account of the change in the legend, which now includes a new layer.

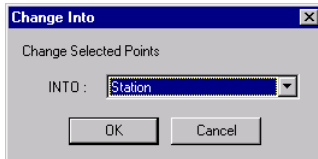
❑ **Deleting an object in a collection from a map document**

- On the map, select the object 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 4SPack to delete the object.

❑ **“Change Into” Function**

This function is used to transform the type of a point. For example, you can change a logged point into a logged reference point. To use this function:

- On the map, select the point you want to change
- On the **Project** menu, select **Change Into...** The following dialog box appears:



- In the **INTO** combo box, choose the new type desired for the point and then click **OK**. As a result, the map is updated to show the type change.

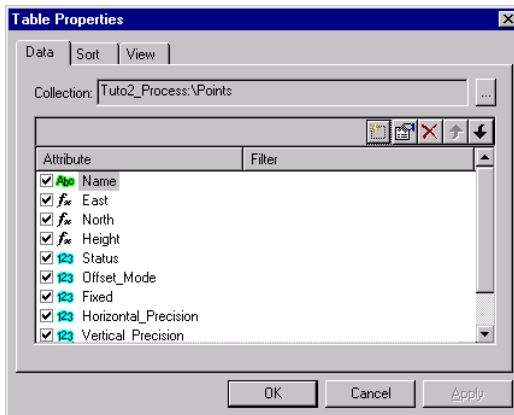
Working in a Table Document

□ Creating a Table Document


- On the menu bar, select **File>New**
- Select “Table” on the Documents tab. Name the new document by typing a name in the **File Name** field (for example type “Table1”)
- Click **OK**. A new blank table document opens on the View pane.

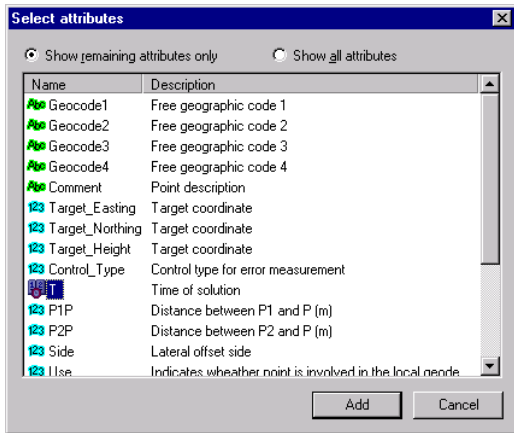
4SPack builds a default table not necessarily containing all the object attributes pertaining to the collection for which you are creating a table document. 4SPack lets you change the organization of the table document to suit your particular needs. For instance you can add/delete data columns, place a filter to list only those objects meeting the filter criteria or list the objects in a given order.

- Open a table document. For example, use the tutorial project called “Tuto2_Process” that you created in Section 4 and open the **Points (All coordinates)** document
- On the menu bar, select **Table>Data**. The **Table Properties** dialog box opens listing all the attributes (columns) currently viewed in the table document for each object (rows) in the collection.




□ Adding an Attribute to a Table Document

- In the **Table Properties** dialog box, click . The new dialog box that opens allows you to choose the attributes that 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 in the table document, simply select it and click **Add**:



The newly added attribute now appears at the end of the attributes list in the **Table Properties** dialog box.

You can change the rank of this attribute in the list.

To do this, select the attribute and click  until the attribute is at the desired position in the list. The first attribute in this list will appear in the first column in the table and so on


- Click **OK**. A new column now appears in the table document. This column contains the attribute you have just added.

❑ 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 concerned column from the table.
To re-enable this attribute in the table document, re-check this button.

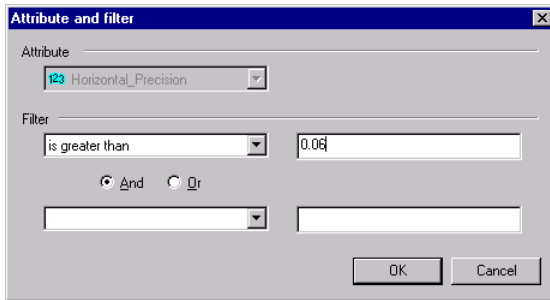
Normal removal:

- 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.

❑ Setting a Filter on an Attribute

Setting filters on attributes allows you to list only those 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 “Horizontal_Precision”.
- Click . In the dialog box that opens, make the following choices:



- Click **OK** (twice). The table document now only consists of a single row showing the only object meeting the filter criterion. This criterion is recalled just under the column header.

Points [All Coordinates].tbl			
	Horizontal_Precision	Vertical_Precision	Type
▼	>0.06		
1	0.076	0.057	Logged Point

Record 0

Design Vie... Graph1.gph Points [All Co...

Working in a graph document

□ Creating a graph document

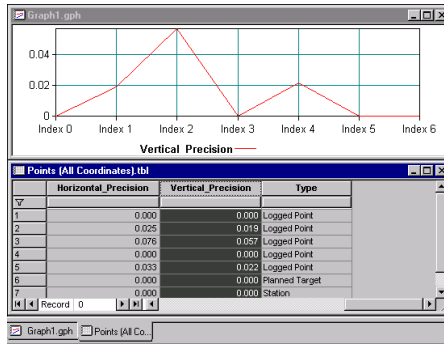
- On the menu bar, select **File>New**
- Select “Graph” on the Documents tab. Name the new document by typing a name in the **File Name** field, for example, type “Graph1”.
- Click **OK**. A new blank graph document opens on the View pane.

□ Defining the X and Y Axes


You need to have a table document open on the View pane to create a graph in the graph document. Choose one or two columns to be involved in the definition of the graph. If you select a single column, then its content will necessarily be used to define the Y axis and a dimensionless, linear scale will be used as default setting on the X axis.

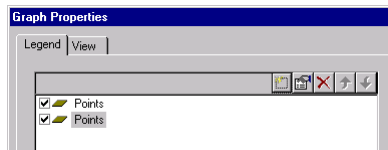
- Open a table document containing some interesting data that you would like to plot on a graph. For example, use the tutorial project called “Tuto2_Process” that you created in Section 4 and open the **Points (All coordinates)** document in this project
- On the **Window** menu, select any of the options allowing 4SPack to show the two documents side by side on the View pane (**Tile Horizontally** for example)
- In the **Points (All coordinates)** document, use the horizontal scroll bar to display the **Vertical_Precision** column
- Select this column by clicking in the column header
- Drag and drop the column header within the empty Graph document.

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



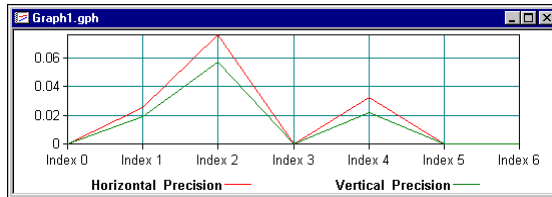
□ Adding a new curve on the same graph

- 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 “Horizontal Precision” 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:



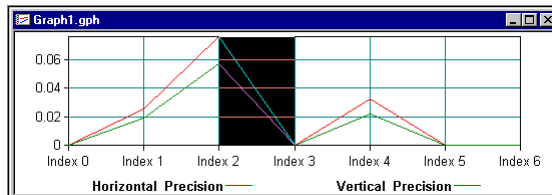
- Click **OK**. Two curves are now plotted on the graph with different colors: one for the vertical precision, the other one for the horizontal precision.

Both use the same X axis.

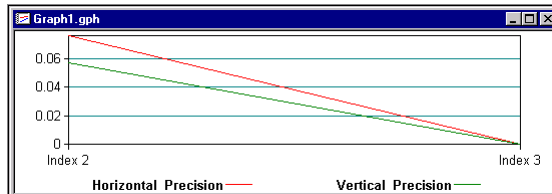


□ Zooming in on a Graph

- 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, 4SPack 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.

Coordinate Systems

The following two types of coordinates systems are supported by 4SPack:

System	Category	Definition	Icon used
2D (horizontal)	Fitted	Projected system + Local correction	
	Projected	Geographic system + Projection type + distance unit and labels used	
	Geographic	Datum definition + angular unit and labels used	
3D (horizontal & vertical)	Compound	Horizontal system (one of the three categories above) + Vertical system	
	Geocentric	Datum definition + distance unit and labels used	
	Datum	Ellipsoid + shift values + scale factor	
	Ellipsoid	Semi-major axis + inverse of flattening	None

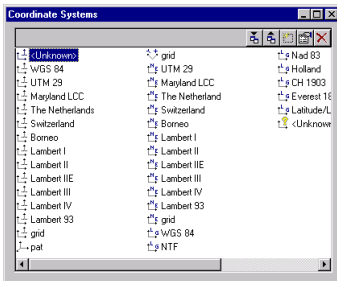
Local correction: Based on the equation of a straight line (with specific value at the origin and specific gradient)

Projection type: Conic stereographic, transverse or oblique Mercator, etc.

Datum: Ellipsoid + shift values

NOTE: 4SPack strictly complies with OpenGIS concerning coordinate transformations.

Use the command **Tools>Coordinate Systems...** on the menu bar to work on the coordinate systems available in 4SPack. The set of available buttons in the upper-right corner of the window allows you to import/export (in text format), add, edit and delete your coordinate systems.



Geocodes & Operators

In the **Project Settings** dialog box that you can access from the **Project** menu, 4SPack lets you define a list of operators and a list of geocodes for the project. Any list of operators or list of geocodes can be saved as a text file for further use. To work with a list previously saved as a text file, use the **Load** button to load this file into 4SPack.

The list of operators may be useful for real-time surveys. When you upload a job to field equipment, you can specify the name of the operator in charge of the field survey. Later on, this name will be downloaded to 4SPack together with the associated field results. This allows you to know the names of the different operators that worked on the survey.

The list of geocodes is just a memo to remind you of the meaning of each of the geocodes used in your surveys.

To access these two lists, on the menu bar, select **Project>Edit Settings...** The list of geocodes is shown on the **Geocodes** tab. The list of operators is shown on the **Operators** tab.

Editing an Object in a Collection

As you progress in your survey, and before you undertake such operations as baseline processing or network adjustment, the objects you are working on may require edits to some properties. Note however, not all the attributes can be changed.

Typically, you may need to edit a point to change the following attributes:

. Classic attributes:

- Name
- Type
- Geocodes
- Comment

And also:

- Control type: this attribute is used to define the spatial dimension of a point (1D, 2D or 3D). For example, selecting 1D for a point means that only its Z or Altitude coordinate will be used in the computations involving this point.
- Fixed (Constraint): this attribute defines the degree of freedom assigned to a point (floating, fixed horizontally or/and vertically). This parameter is of the utmost importance in the baseline processing and network adjustment procedures. It is the user's responsibility to know how each point should be set regarding this attribute.
- Target coordinates (if appropriate): only relevant to planned points for which theoretical coordinates ("target" coordinates) are defined in a real-time project. The field equipment in fact uses these coordinates (stored in the job in progress) when guiding the field operator to these points (staking-out operations)

. Geometric attributes:

- Location (approximate, computed, preset or adjusted depending on how far you are in your survey)
- Spatial reference system in which the point's coordinates are expressed.

Editing an object stored in the project database can only be achieved from within a map or table document created in the project. Whatever the document you use to do this, the changes will then appear in both documents, and also in any other document in the project mentioning this object.

Accessing the Properties dialog box from a map document:

- Select a point on the map
- Right-click on this point and select **Properties** in the pop-up menu
- In the dialog box that opens, make the changes required.

Accessing the Properties dialog box from a table document:



- Select the row in the table providing the attributes of the point
- Right-click anywhere on this row and select **Properties** in the pop-up menu
- In the dialog box that opens, make the changes required.

The screenshot illustrates the workflow for accessing the Properties dialog box from a table document. It shows a table with columns 'Name' and 'East'. Row 3 is selected, and a context menu is open with 'Properties' highlighted. An arrow points from the 'Properties' option in the context menu to the 'Points "Lch_0320" Properties' dialog box. The dialog box shows the 'Location' tab with fields for Name (Lch_0320), Type (Logged Point), Geocode1-4, Comment, Target_Easting, Target_Northing, Target_Height, and Control Type (None).

	Name	East
1	Lch_0320	310431.216
2		309294.656
3		306208.277
4		297972.005
5		311446.920
6		294793.713
7		298760.013

Creating Custom Formats

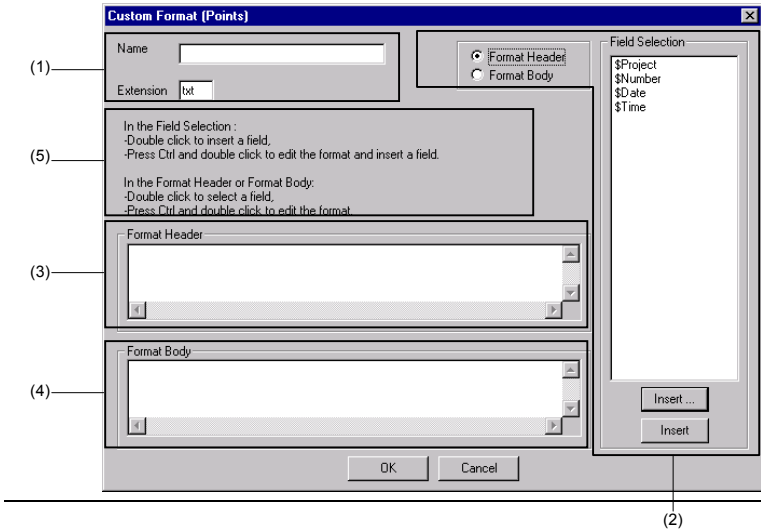
With 4SPack, you can easily create a data import or export format suited to your needs. All the creation process takes place within a single dialog box that you can access by following the procedure below, after opening a project in 4SPack:

- On the 4S Pack menu bar, select **Project>Import Data From Files...** or **Project>Export Data to Files...**
- 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 buttons + 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 providing instructions on how to use this dialog box (5).

Dialog box allowing you to create a custom format:

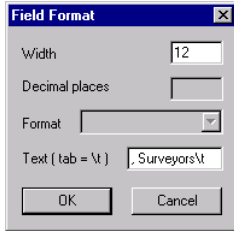


To create a new custom format, follow the instructions below:

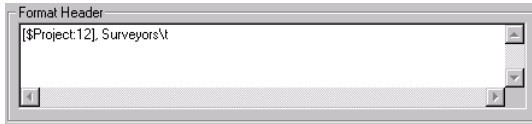
1. In the **Name** field, enter a name for the new format. In the **Extension** field just below this field, enter the file extension (3 characters max.; default: txt) for the created file
2. Start with the definition of the header by checking the **Format Header** radio-button. All the fields that can 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 spec if it's a date or time, 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 on 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.



Note that 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. If you now select another field from the **Field Selection** list box and you click on the **Insert** (instead of the **Insert...**) button, then the field will be directly inserted into the **Format Header** edit box, keeping the same formatting instructions, if applicable, as the ones you have defined previously for the **\$Project** field.

6. 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 (see example on page 106 in which the inserted words are in fact the column headers corresponding to the fields entered in the **Format Body** edit box)
7. 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
8. Follow the instructions from points 3. to 5. above to create the format body. The instructions mentioned in the dialog box (see area (5) on page 106) are an alternative to the procedure described above
9. 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...**). ♣

4. Post-Processing Survey Principles

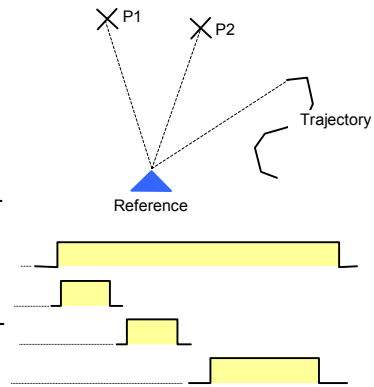
Field Survey Objectives

Post-processing surveys are performed in the field using Thales Navigation receivers for logging GPS raw data on the sites to be surveyed.

Potentially, from each data block in a log file, a straight GPS position can be determined for the receiver location when the data block was logged. The longer the logging time, the larger the number of data blocks available for the post-processing phase.

In order to reach centimeter-level accuracies for each of the points being surveyed, raw data files must be logged simultaneously in two distinct receivers.

One must be operated as a stationary unit at a known fixed point (it is then called the station), the other one is operated successively on each of the surveyed sites (and is called the rover). Several algorithms are used in the post-processing phase with gradually increasing precision (Floating, Wide Lane, Fixed), which ultimately lead to centimeter precision.



The surveyed site is either a single point, or a trajectory that may include specific site occupation (Stop & Go). In the first case, logging takes place at a fixed point and so is said to be “static”. In the other case, it is performed while the receiver is moved along the trajectory and so is known as “dynamic” or “kinematic”.



- If the files logged on the surveyed point do not correspond in time to any other file logged at fixed point, the best position solution that you can expect for the surveyed site will only be an average of all the straight GPS solutions determined from the data blocks in these files.



- Static log files does not differ in essence from dynamic log files. For this reason, it is essential for the user to remember in which conditions files are logged when he/she imports them into 4SPack.

Recommended Occupation Times

With recording rate= 1 second and minimum 5 satellites properly received:

- 10 minutes + 1 minute/km with single-frequency (L1) receivers
- 5 minutes + 0.5 minute/km with dual-frequency (L1/L2) receivers

Operating Ranges

- Up to 15 km (9 miles) with single-frequency (L1) receivers
- Up to 50 km (31 miles) with dual-frequency (L1/L2) receivers

4SPack Internal Processing Steps Tied to Raw Data Import

(Project>Import Data from Files command; choose to import **Raw-data Files**)

When importing a raw data file (observation file) into the active project, after the user has provided a *File* name, a *Point* name and has specified whether the file results from static or dynamic logging, the following takes place in 4SPack:

1. The data blocks from the imported file are stored in the project database, more precisely in the *GPS_Measurement* folder as a new collection named: "<File_name>"
2. *Broadcast_Ephemeris* and *Broadcast_Iono* collections are possibly updated. The updating will take place only if the ephemeris & ionospheric data present in the imported file are different from those already present in the project database.
3. An approximate position (let's call it "P0") is determined in straight GPS mode using the first data blocks from the <File_name> collection. This computation is made regardless of the type of imported file (i.e. static or dynamic)¹
4. A new object is added to the project database in the *Files* collection. This object provides a full description of the imported file and also includes the name of the associated point (name provided by the user at the beginning of the import operation) + the approximate P0 position computed in the previous step². A file object is said to be static or dynamic if it proceeds from, respectively static or dynamic logging.

¹ For a static log file, computing this coarse solution will allow 4SPack to locate the surveyed point on any map document created in the project. For a dynamic or "Stop & Go" log file, 4SPack will be able to "anchor" the surveyed trajectory on the map from its start point.

² Assigning P0 to the file also allows 4SPack to locate the file on a map. P0 is definitively tied to the file whereas the same P0, assigned to the point, will be updated as new computations are run to refine this position.

5. Finally, a new object is created in the *Points* collection³ and P0 is assigned to this point. If however a point already exists in the database with the name specified at the beginning of the import operation, no new object will be created in the *Points* collection and, in this case, P0 will not be assigned to this point.

In the case of a “Stop & Go” survey, 4SPack will update the *Stops* collection to report all the marks (or events) detected in the log file.

6. In the project database, 4SPack searches for files that coincide in time, partially or completely, with the file that has just been created.
7. If concomitant files are found, new objects are created in the *Processes* collection. Each of these objects describes a baseline⁴. The baseline is oriented 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
 - Involved in a large number of baselines
 - Associated with a long observation.

³ Surprisingly, this step also applies to a dynamic log file. In fact, as long as a trajectory remains unprocessed in 4SPack, it is assumed to be a point, which means a point whose position is that of the trajectory’s start point, as explained in footnote ².

⁴ A baseline is defined as the straight line between the two points associated with a pair of simultaneous observation files.

Baseline Processing

(Project>Process Baselines...command)

To process a baseline, 4SPack needs:

- The point providing the reference position
- A file the reference point is associated with
- The surveyed site (a point or the start point of a trajectory)
- A file the surveyed site is associated with
- An indication on the processing mode to use: “static” if the file associated with the surveyed site is static, “dynamic” if it is dynamic or “Stop & Go” if it’s a dynamic survey during which the survey receiver was informed of the moments when it was kept stationary (marks, or “events” logged in the observation file)
- To know the processing options.

□ Static

(Static mode selected)

The following processing steps are run in 4SPack:

1. An optimized L1 or L1/L2 float solution is determined for the surveyed site.
2. An optimized Wide Lane solution is determined (only if L1/L2 data is available)
3. An optimized L1 or L1/L2 fixed solution is determined.
4. An ultimate solution is computed, with the best possible accuracy
5. The ultimate result is stored in the *Points* collection, in the object corresponding to the surveyed site (unless this site is held fixed)
6. The vector resulting from the above processing is built. It is oriented from the reference to the computed point.
7. A new object is created in the *Vectors* collection showing how the vector is built. The vector is identified by the two points from which it proceeds and therefore has no proper name.

NOTE: At the beginning of the procedure, you can specify a point name different from that of the surveyed site and associate the file available for this site with the new name. As a result, the ultimate solution will automatically be saved as a new object in the *Points* collection. This way of working allows you to save several solutions for the same surveyed site. In this case however, it is the user's responsibility to use appropriate naming so that he/she does not get lost amid all the solutions available.

□ **Dynamic**

(Dynamic mode selected)

The following processing steps are run in 4SPack:

1. All objects in the *Points* and *Vectors* collections pertaining to the trajectory being processed are deleted if this trajectory already exists in the *Lines* collection.
2. A certain number (n) of optimized floating or fixed solutions are computed for all epochs for which GPS measurements are available.
3. The n solutions are saved as n objects in the *Points* collection
4. The n points are linked to form the trajectory
5. An object is created in the *Lines* collection. It is named like the site from which it proceeds. The set of n points making up the trajectory is then defined as the geometric attribute of the new object. If however the trajectory already exists in the collection, its geometric attribute is updated with the set of n points computed. The object from the *Points* collection involved in this processing is updated as the first point of the trajectory.

□ Stop & Go

(Stop & Go mode selected)

The following processing steps are run in 4SPack:

1. An optimized L1 or L1/L2 float solution is determined corresponding to each mark present in the *Stops* collection
2. An optimized Wide Lane solution is determined (only if L1/L2 data is available) for each of these marks
3. An optimized L1 or L1/L2 fixed solution is determined for each of these marks
4. An ultimate solution is computed, with the best possible accuracy, for each of these marks
5. The ultimate results are stored in the *Points* collection
6. The vectors resulting from the above processing are built. They are oriented from the reference to the computed points
7. New objects are created in the *Vectors* collection showing how the vectors are built. The vectors are identified by the two points from which they proceed and therefore have no proper names.



- Unlike the processing of a trajectory, no object is created in the *Lines* collection and no intermediate points are stored in the *Points* collection..

Sites computed individually

(Project>Process Single Site... command)

To determine a solution for a site taken separately, 4SPack needs:

- The name of the surveyed site (a point or a trajectory)
- An observation the surveyed site is associated with
- An indication on the processing mode to use: “static” if the observation associated with the surveyed site is static, or “dynamic” if it is dynamic or of the Stop & Go type.

Static Processing (Static mode selected)

The following processing steps are run in 4SPack:

1. From all the pure GPS solutions deduced from the observation, an average position solution is computed for the site
2. The result is stored in the corresponding object in the *Points* collection. If the object does not exist, it is then created.

Dynamic Processing (Dynamic mode selected)

The following processing steps are run in 4SPack:

1. All objects in the *Points* and *Vectors* collections pertaining to the trajectory being processed are deleted if this trajectory already exists in the *Lines* collection.
2. n pure GPS solutions are computed for all epochs for which GPS measurements are available
3. The n solutions are saved as n objects in the *Points* collection
4. The n points are linked to form the trajectory
5. An object is created in the *Lines* collection. It is named as the site from which it proceeds. The set of n points making up the trajectory is then defined as the geometric attribute of the new object. If however the trajectory already exists in the collection, its geometric attribute is updated with the set of n points computed. The object from the *Points* collection involved in this processing is updated as the first point of the trajectory.

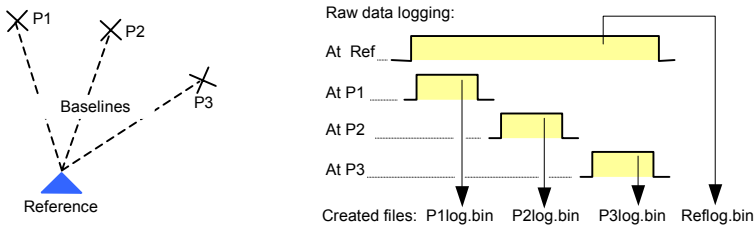
Survey Schemes

□ Static

1st step: Field Survey

Assuming the following survey example: 1 reference point on which a Thales Navigation 6502 SP receiver logs raw data for about 30 minutes.

Another receiver, for example a Thales Navigation 6502 MP, is moved successively on points P1, P2 and P3. The receiver is kept at standstill on each point for about 10 minutes during which raw data is logged by this receiver. These logging sequences coincide in time with that performed at the reference point.



2nd step: Creating a new land survey project with 4SPack

Use the **File>New** command to create a land survey project (and a workspace).

3rd step: Importing raw data files into the project database

Use the **Project>Import Data from Files** command to import the files logged in the field (P1log.bin, P2log.bin, P3log.bin, Reflog.bin). The following is then performed in the project database:

- In *GPS Measurement* folder, a new collection is created for each imported file

- In the *GPS_Data* folder, ephemeris & iono data collections are updated if different from those already present in the database
- In the *Files* collection, a new object is created for each imported file
- In the *Points* collection, a new object is created for each imported file (unless already existing)
- In the *Processes* collection, as simultaneous observations are found, 3 objects are created to describe the following 3 baselines in our example: RefP1, RefP2, RefP3.

Before proceeding to the next step, the operator has to enter the coordinates and attributes of the reference point.

4th step: Processing baselines

Use the **Project>Process Baselines...** command. Choose the adequate processor to perform this operation. Two different processors are available: Static or Dynamic. For the present example, the Static processor is the one to be used to determine the three baselines.

After the validation step, the ultimate results are stored as objects in the following collections:

- *Vectors*
- *Points*

Vectors may be adjusted using **Project>Adjust Baselines...** if there is sufficient redundancy in the measurements, which is highly desirable.

5th step: Analyzing results & creating a report

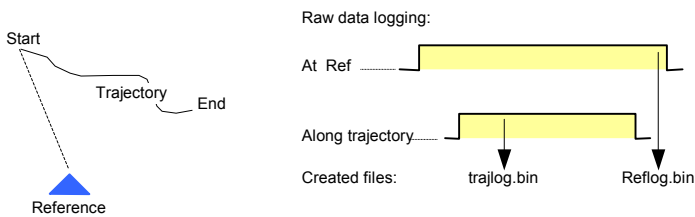
Use the **Project>Generate Report...** command to generate a project report. There are several types of reports available. Each type results from the execution of a specific VB Script macro saved in *...\Studio\Macro*. Each of these macros drives 4SPack to format the data read from the database.

□ Dynamic

1st step: Field Survey

Assuming the following survey example: 1 reference point on which a 6502 SP type receiver logs raw data for about 30 minutes.

Another receiver, for example a 6502 MP, is moved along a trajectory while logging raw data. The two logging sequences coincide in time.



2nd step: Creating a new land survey project with 4SPack

Use the **File>New** command to create a land survey project (and a workspace).

3rd step: Importing raw data file into the project database

Use the **Project>Import Data...** command to import the files logged in the field (trajlog.bin, Reflog.bin). Don't forget to select the **Dynamic** check box before importing trajlog.bin (this will automatically set the processing of the resulting baseline to **Dynamic** or **Stop & Go** if files contain events). The following is then performed in the project database:

- In *GPS_Measurement* folder, a new collection is created for each imported file
- In the *GPS_Data* folder, ephemeris & iono data collections are updated if different from those already present in the database
- In the *Files* collection, a new object is created for each imported file

- In the *Points* collection, a new object is created for each imported file or is updated if the object already exists. See Footnote 3 on page 112 for the description of the site created for the rover.
- In the *Processes* collection, as simultaneous observations are found, an object is created to describe the following pseudo-baseline in our example: RefStart.

Before proceeding to the next step, the operator has to enter the coordinates and attributes of the reference point.

4th step: Processing baselines

Use the **Project>Process Baselines...** command. Choose the adequate processor to perform this operation. Two different processors are available: Static or Dynamic. For the present example, the Dynamic processor is the one to be used to determine the trajectory.

After the validation step, the ultimate results are stored as objects in the following collections:

- *Points*
- *Lines*

As there cannot be any redundancy in the data recorded when surveying a trajectory, there is no point in using the network adjustment command.

5th step: Analyzing results & creating a report

Use the **Project>Generate Report...** command to generate a project report. There are several types of reports available. Each type results from the execution of a specific VB Script macro saved in ...\\Studio\\Macro. Each of these macros drives 4SPack to format the data read from the database.

□ **Stop & Go**

Follow the same steps as in Dynamic section except for the following:

- 3rd step: 4SPack also feeds the *Stops* collection after analyzing the marks found in the imported file. In the *Processes* collection, new objects are created only for the detected marks
- 4th step: no new object is created in the *Lines* collection. ♣

5. Real-Time Survey Principles

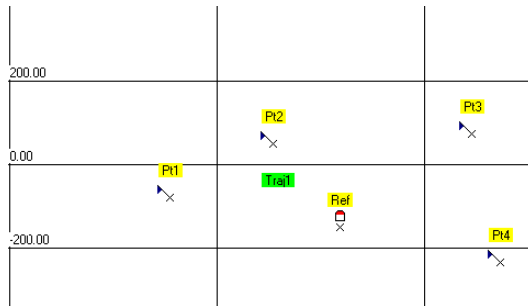
Survey Scheme

1st step: Creating a new land survey project with 4SPack

Use the **File>New** command to create a real-time project (and a workspace).

2nd step: Preparing a job with 4SPack

In the open real-time project, create a map document to create/import all the points needed for your survey (reference, target points, etc.). An example of a job is shown on the map document below:



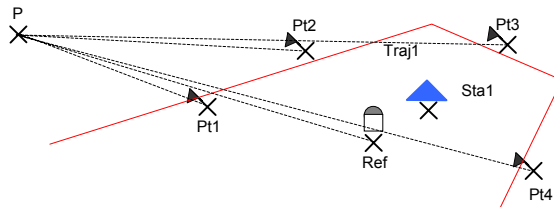
3rd step: Uploading the job to the field system

Use the **Project>Upload real-time job...** command to upload the job to the survey terminal.

4th step: Field Survey

Assuming the following survey example: a Thales Navigation 6502 SK station is operated at an accurately known point throughout the duration of the survey.

Another receiver, for example a Thales Navigation 6502 MK rover, is used to take the field operator to the different points and trajectory described in the job.



Once the field operator has accurately placed the rover antenna on each of the targets, he/she can place stakes on these points and save the position then computed by the receiver for further cross-checking. He/she can also be guided along a preset trajectory, for example to stake it out.

In addition to the job itself, the field operator can also compute and save the position of any interesting point located in the working area (including control points, also for the sake of cross-checking) or log points along a trajectory at regular intervals of time or distance.

5th step: Downloading survey results

Use the **Project>Download real-time results...** command to download the survey results into the original real-time project. The results will appear immediately on the project map according to the current settings of style and display filter for the concerned collection types.

6th step: Analyzing results & creating a report

Use the **Project>Generate Report...** command to generate a project report. There are several types of reports available. The generation of each type results from the execution of a specific VB Script macro saved in ...\\Studio\\Macro. Each of these macros drives 4SPack to format the data read from the database. ♣

6. Post-Processing Algorithms

When you run the **Project>Process Baselines** function, the pair of data files associated with each baseline is processed several times, each time in a different mode starting from the less precise, up to the most precise.

In the case of single-frequency raw data files, the processing modes used are:

- First “L1 Float”
- Then “L1 Fixed”

In the case of dual-frequency raw data files, the processing modes used are:

- First “L1/L2 Float”
- Then “Wide Lane”
- Then “L1/L2 Fixed”

Each step produces a position solution specific to the processing mode used. This fully qualified solution is used as the “approximate position” in the next processing mode run by 4SPack.

If at the end of the processing, the fixed solution does not pass the validation test, 4SPack will reject this solution and will only keep the float solution.

The post-processing algorithms implemented in 4SPack provide the following precision figures (fixed solutions):

- 3 mm + 0.5 ppm (static)
- 10 mm + 1 ppm (kinematic)

1σ RMS figures, on a clear site, in normal conditions of GPS reception (normally active ionosphere, 5 satellites used and HDOP<4). ♣

7. Network Adjustment

Introduction

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 straightforward.

The primary components of a least-squares adjustment are the survey observations (angles, distances, elevation differences, and, in this case, GPS 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 4SPack.

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.

Running a Network Adjustment

When 4SPack performs a network adjustment, detailed information is reported in the Output pane concerning the adjustment in progress. Below is an example of what can be read on the output pane.

```
Performing adjustment...
FILLNET - Ashtech Network Adjustment Package
Copyright © 2002 THALES Navigation All rights reserved.

Tuesday, May 21, 2002 10:59:21 AM

Network connectivity test: passed
Number of sites: 5
Number of vectors: 10

Adjustment type: Minimally constrained
Control sites Constraints
Ser_0320 Latitude Longitude Elevation
LCPC_0320_S Latitude Longitude Elevation

Adjustment Tests
Confidence level: 95.0%
Number of
  obs. equations 34
  unknowns 16
  degrees of freedom 18
Chi-square test: failed
  Lower limit: 8.230746
  Upper limit: 31.526379
  Chi-square: 117.940746
Variance of Unit Weight: 6.552264
Standard Error of Unit Weight: 2.559739
Critical value for Tau-test: 2.865394
Scale factor for a-priori vector sigmas: 1.00

Reference Ellipsoid Parameters
Equatorial radius (semi-major axis): 6378137.000
Reciprocal of flattening: 298.257223563
```

Each adjustment step reported in this pane is detailed hereafter.

□ **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).

□ **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. 4SPack 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.

□ 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. GPS observations have three residuals, one for each component of the GPS vector (X,Y,Z or N,E,U).

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. 4SPack 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.

□ Tau Test

Examining residuals is a good indicator of the quality of individual observations. As stated earlier, the expected value of residuals/normalized 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 4SPack. Each residual is tested and the outcome of the test is presented in a check button along with the residuals for each observation. If the button is checked, this means that the residual has passed the Tau test.

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. ♣

8. Pred Utility

Introduction

Pred 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 opposite) allows you to quickly define an observation point.

Pred 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.

Pred allows you to import new sets of almanac data saved in Thales Navigation formats (SFIX, SVAR or SBIN), or of the following type:

SEM<Week No.>.TXT (almanac files downloaded from the US coast-guards site: www.navcen.uscg.gov).

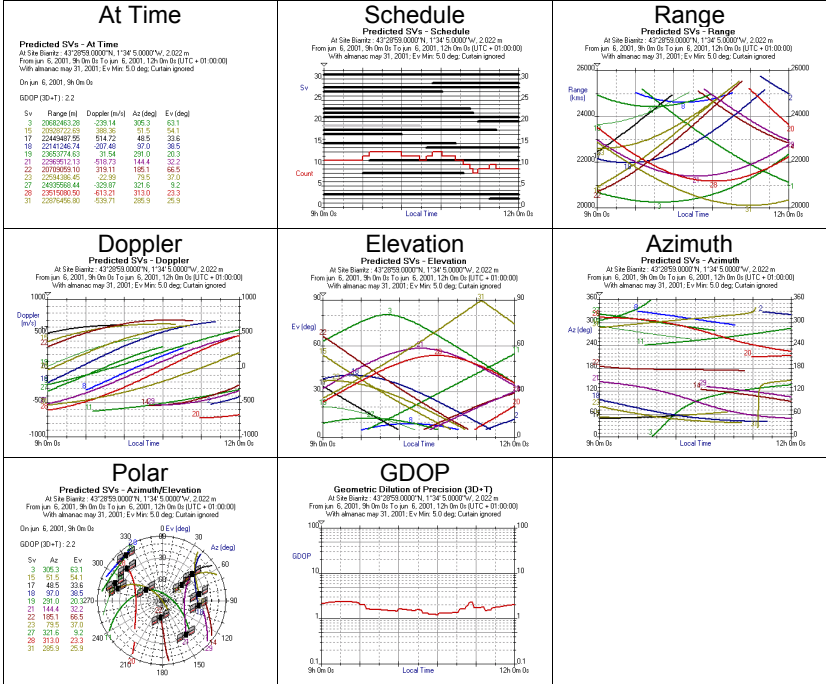
Pred can also display the set of almanacs used (see opposite).



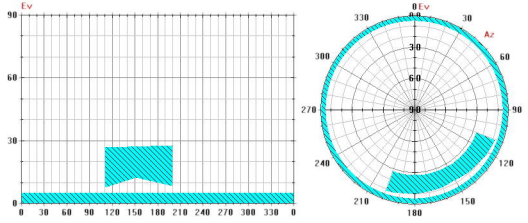
Prediction - Almanac (1 / 29)	
Thursday, May 31, 2001 - 16:38:24	
SV PRN :	1
Health :	0
Eccentricity :	0.51250458E-2
Time of Applicability (s) :	405504
Orbital Inclination :	55°16' 5.6433"
Rate of Right Ascen (deg/s) :	-4.6428E-7
Semi-Major Axis (m) :	26558562.250
Right Ascen at TOA :	212°34' 6.6688"
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

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Pred produces the following views to help you analyze the results of the prediction:




Pred also allows you to edit curtains and to apply them to the observation point (see Curtain Editor below). 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

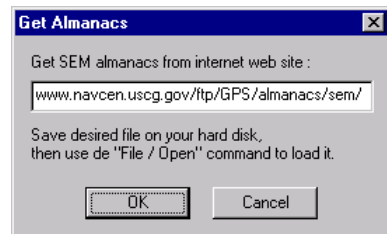
When launching **Pred**, the set of almanacs last loaded is used. To open a new set of almanacs:

- 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)
 - SEM almanacs from the US coast guards (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 supposes 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 **Pred** 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 TODA :	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

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Defining the observation point

When launching **Pred**, a prediction for the last selected observation point is run.

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 (xx characters max.)

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 page 158)

Alt Define the point's altitude by completing manually this field

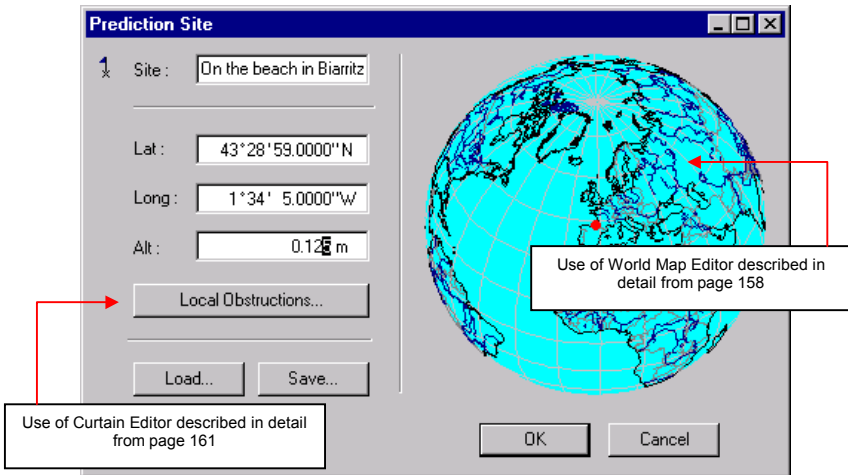
Local Obstructions...

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 page 161 and next ones.

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:




Defining the date & time of prediction

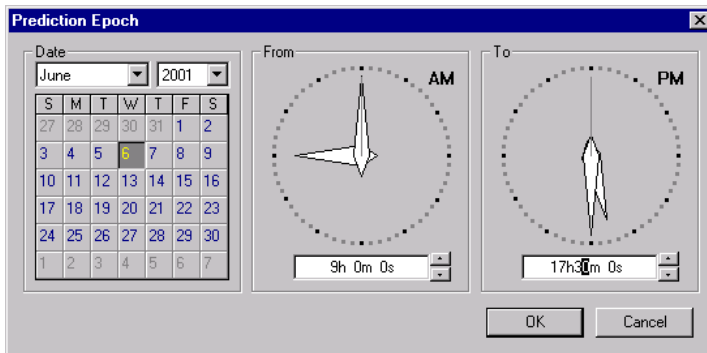
When launching **Pred**, a prediction for the current date & time is automatically computed.

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:

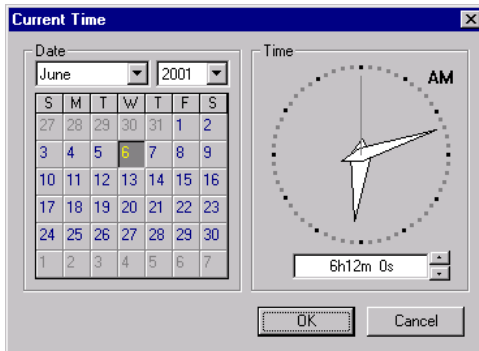


Defining a moment within the prediction

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:



NOTE : This particular moment in the prediction can be shifted graphically on any prediction view. See page 155.

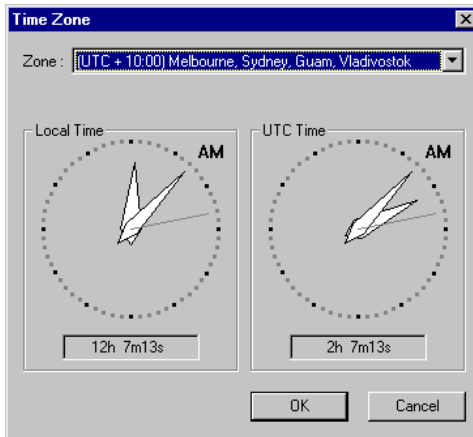
Defining the local/ UTC time deviation

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

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 :

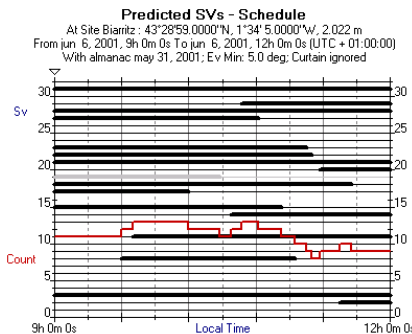
Predicted SVs - At Time				
At Site Biarritz : 43°28'59.0000"N, 1°34' 5.0000"W, 2.022 m				
From jun 6, 2001, 9h 0m 0s To jun 6, 2001, 12h 0m 0s (UTC + 01:00:00)				
With almanac may 31, 2001; Ev Min: 5.0 deg; Curtain ignored				
On jun 6, 2001, 9h 0m 0s				
GDOP (3D+T) : 2.2				
Sv	Range (m)	Doppler (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	22369512.13	-518.73	144.4	32.2
22	20709059.10	319.11	185.1	65.5
23	22594386.45	-22.99	79.5	37.0
27	24936568.44	-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.

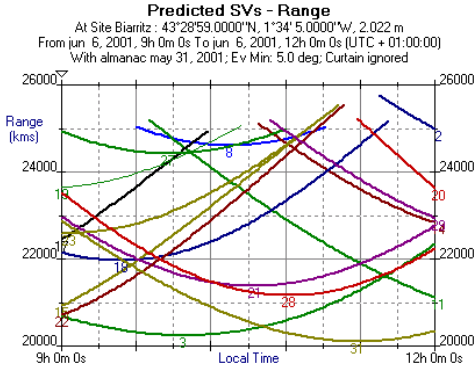
Example of “Schedule” view:



□ “Range” view

This view shows the variations of distance between each of the visible satellites and the observation point.

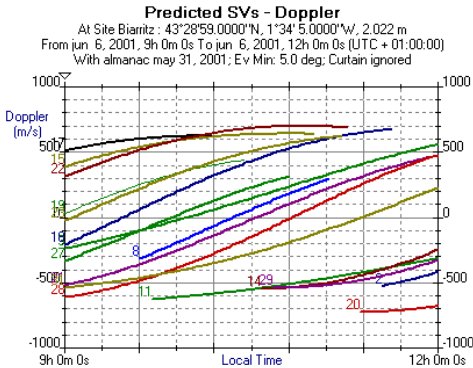
Example of “Range” view:



□ “Doppler” view

This view shows the variations of speed for each of the visible satellites with respect to the observation point.

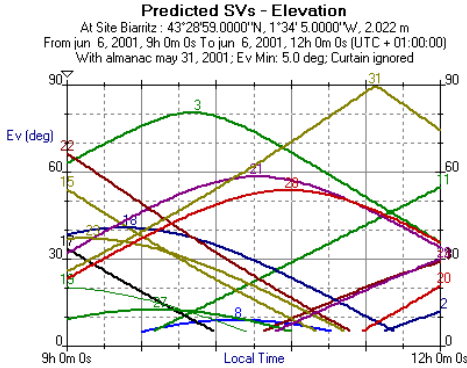
Example of “Doppler” view:



□ “Elevation” view

This view shows the variations of elevation for each of the visible satellites during the prediction.

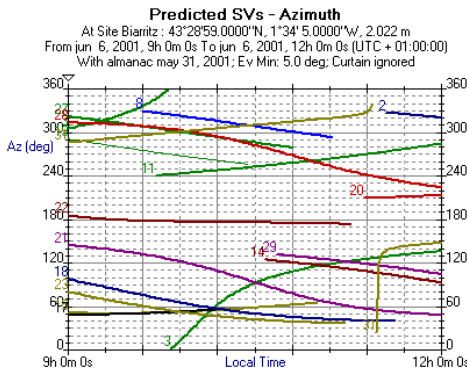
Example of “Elevation” view :



□ “Azimuth” view

This view shows the variations of azimuth for each of the visible satellites during the prediction.

Example of “Azimuth” view :

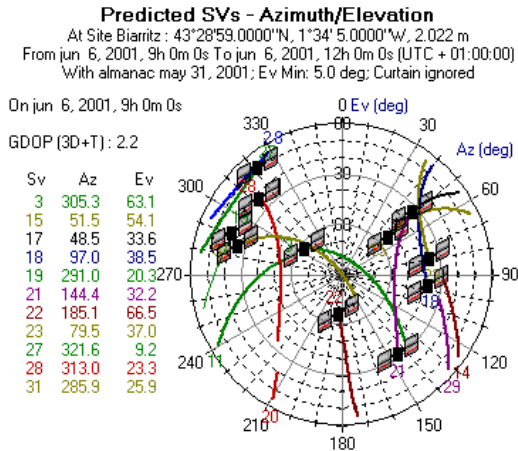


□ “Polar” view

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

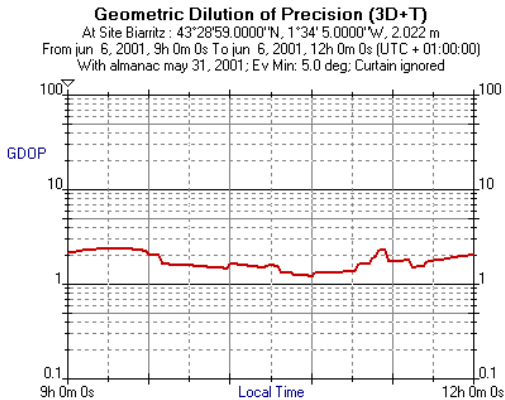
Define the type of fix computation envisaged at the observation point so that **Pred** can determine the corresponding DOP values:

- 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.



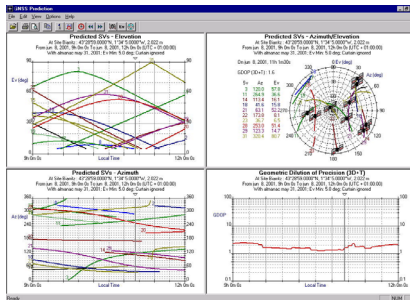
Example of “GDOP” view:



□ 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:



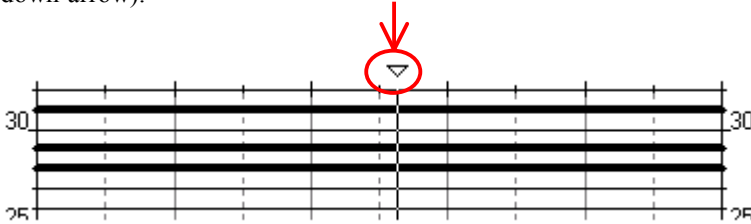
- To choose a different view in an area, position the mouse cursor anywhere within the area and then select the desired view from the menu displayed after a right click
- Switching to two views and then back to a single view are simply obtained by dragging the concerned border out of the window or by 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 (defined in page 146) 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 box 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.
 - 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

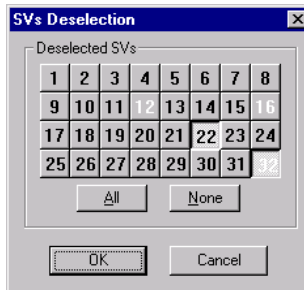
□ Deselecting satellites

- 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:

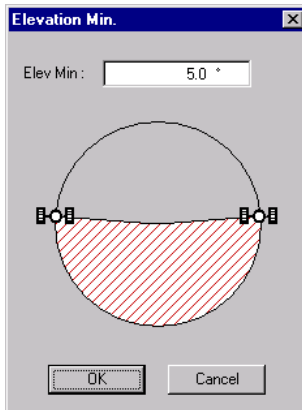


In this example, satellites No. 12, 16 and 32 are not visible, satellite No. 22 is visible but deselected, satellite No. 32 is not visible and furthermore is deselected. All other satellites are visible and used.


□ 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.

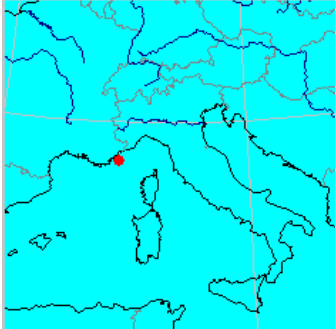
The curtain, which is part of the observation point definition (see page 143), describes an angular area seen from the point. All GPS signals received from that area will NOT be used.

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 making possible a good 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 Ev** 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.

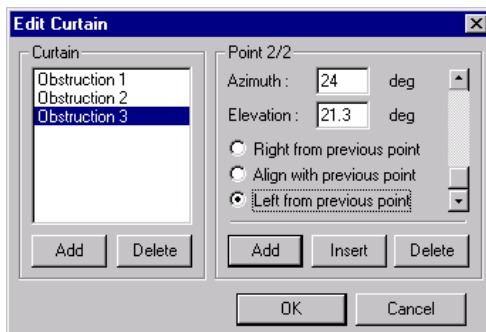
❑ Drawing a curtain

- 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 $0/360^\circ$ or $360/0^\circ$ 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 close 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 $0/360^\circ$ 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. ♣

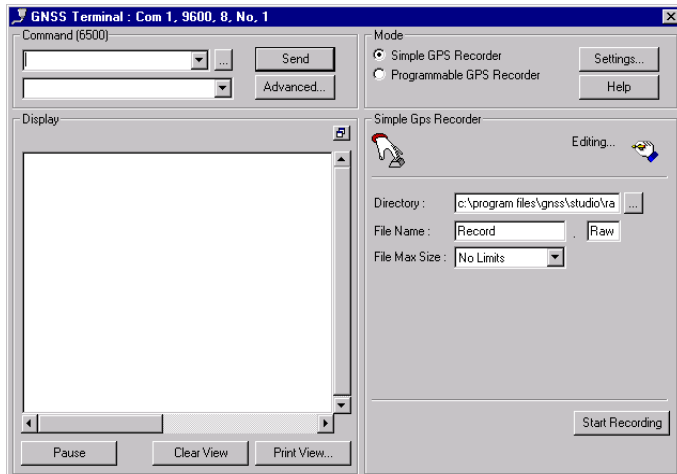
9. WinComm Utility

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 Thales Navigation receivers)
- Identification of the connected GPS receiver (on operator's request, only with Thales Navigation 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.

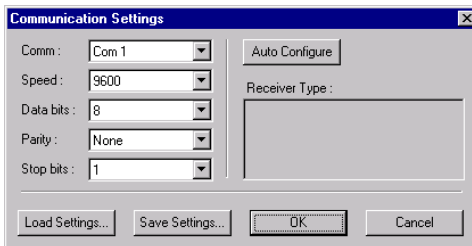
WinComm main window:



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 that 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 Thales Navigation 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 Thales Navigation receivers as this requires that the receiver be capable of returning 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 Thales Navigation receiver.

```
Receiver Type :  
GNSS  
TD00,RUHFV10300  
CM08,CMFYB0020410  
CM08,CMBLX0000028
```

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 extension). Typically, serial port configuration parameters are saved to the 'set' directory.

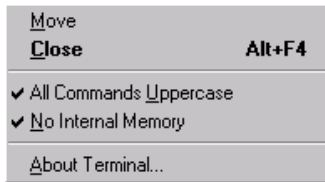
Clicking the **Save** button saves the following communication parameters:

- 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).

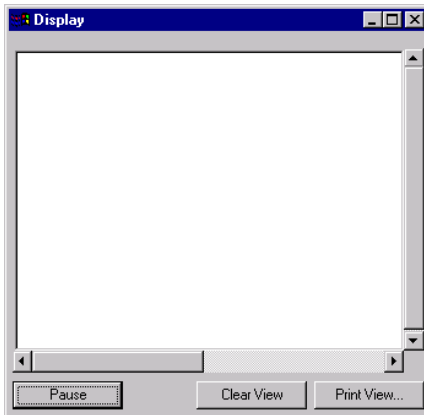
Display area

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.

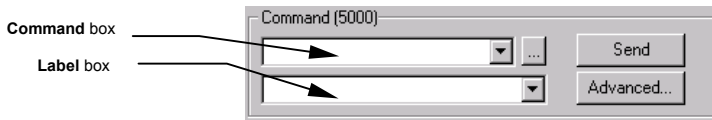
Pause : Freezes the **Display** pane/window and changes the label of the button to **Resume**.

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.

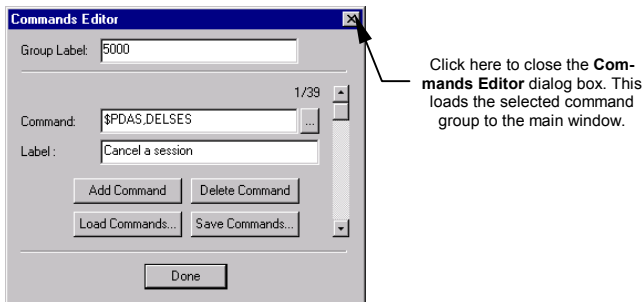
❑ **Commands editor dialog box**

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).



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

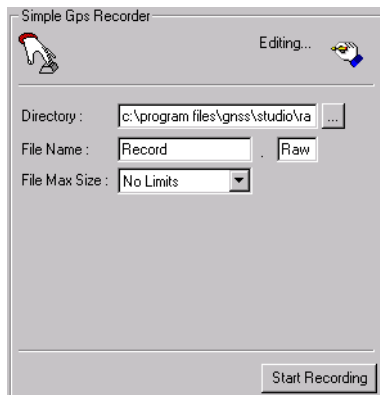
Command : Used to enter and/or view each command script. Use the associated scrollbar to browse through the list of available commands

- 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 so that 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.



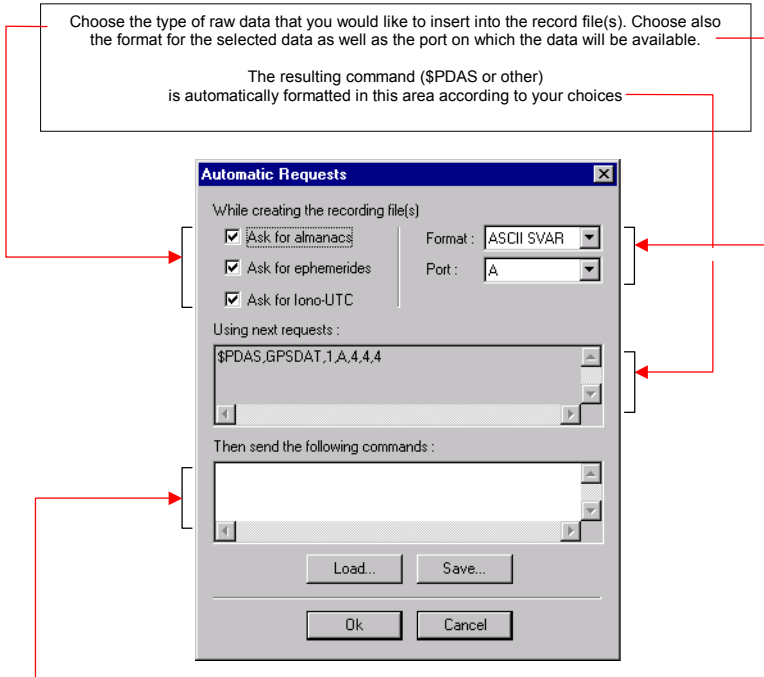
File Name : Used to specify the name of the file to which you wish to record the data from the receiver.

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 a view to storing it on floppy disks for example).

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 re-record, if any, before you effectively enable data recording.



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.

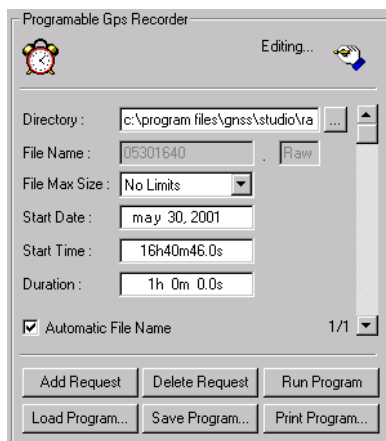
Then click on the **OK** button to start the data recording.

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 a view to storing 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.

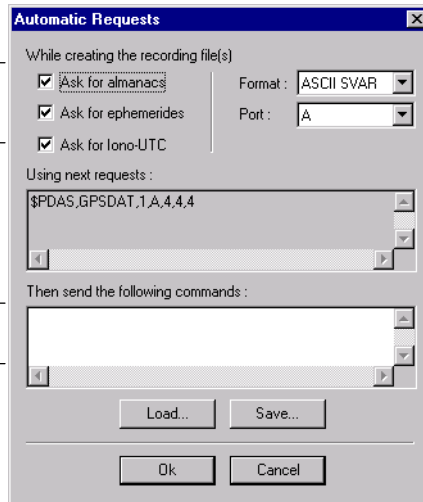
Add Request : This button saves the recording session description currently displayed and increments the number of programmed sessions that appears at the bottom of the scrollbar. (This automatically selects the **Automatic File Name** option and prompts the next possible session, considering the specified 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.

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 inhibited 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 in between.
- 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. ♣

10. 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 Thales Navigation receiver
- Reading the geoid model currently used in a receiver.

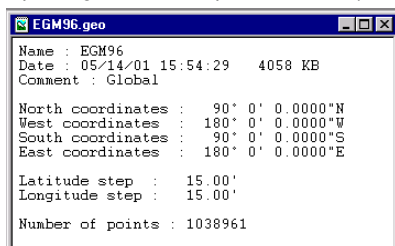
The following formats exist in **Geoids**:

- EGM96 (worldwide model)
- RAF98 (for France only)
- GSD95 (Region of the Saint Laurent in Canada)
- NAP (Normaal Amsterdams Peil)
- North Sea (Land Sea)

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).

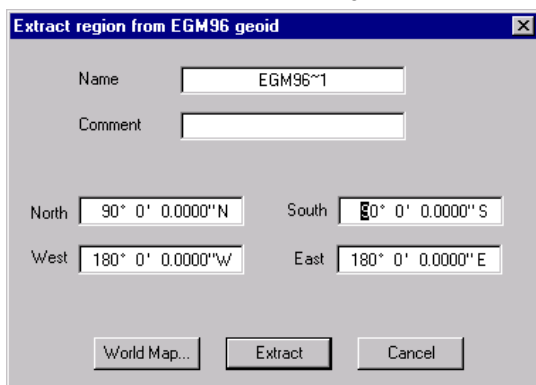
Example of geoid model open in Geoids (EGM96) :



Extract a region from the geoid model

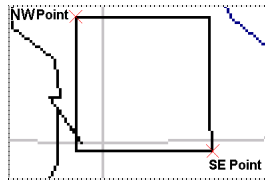
1. Select **File>Open** and choose the geoid model from the displayed list. **Geoids** will extract the data for your region from this model. Then click **OK**. The selected model appears in **Geoids**
2. Select **File>Extract As...** A new dialog box is displayed in which you can define the geographical area you are interested in.

Definition box for data extraction from a geoid model:



3. Define the following parameters:
 - File name (8 characters max.)

- 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.

To use the World Map editor, click on the **World Map** button and follow the instructions provided on page 158, except for the **Draw** function which in the present case must be used to surround the desired 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:

A screenshot showing the workflow of data extraction. On the left, a 'World Map' window displays a map with a cyan-shaded rectangular region. A red arrow points from this region to the 'Extract region from RAF98 geoid' dialog box. In the dialog box, the 'Name' field contains 'RAF98-1' and the 'Comment' field contains 'Poitou'. The 'North' field is '47° 2' 0.0000"N', 'South' is '44° 51' 0.0000"N', 'West' is '0° 38' 0.0000"W', and 'East' is '2° 32' 0.0000"E'. A red box highlights these four fields. A red arrow points from the 'World Map' button in the dialog to the 'RAF98-1.geoid' window on the right. This window displays the extracted data: 'Name : RAF98-1', 'Date : 06/13/01 10:45:17 33 KB', 'Comment : Poitou', 'North coordinates : 47° 3' 0.0000"N', 'West coordinates : 0° 38' 0.0000"W', 'South coordinates : 44° 51' 0.0000"N', 'East coordinates : 2° 34' 0.0000"E', 'Latitude step : 1.50'', 'Longitude step : 2.00'', and 'Number of points : 8633'. Red arrows and text labels are placed below the images to describe each step.

Geographical area covered by initial model

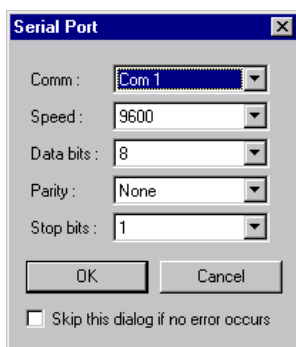
Selected region

Fields automatically filled after making a selection on the World Map editor

Resulting geoid model for the selected region

Uploading a geoid model into a receiver

- Connect an adequate RS232 cable between one of the serial ports on the PC running **Geoids** and one of the ports on the Thales Navigation receiver
- Open the desired geoid model in **Geoids**
- Select **Transfer>Write**. A dialog box appears asking you to specify and configure the serial port used on the PC.



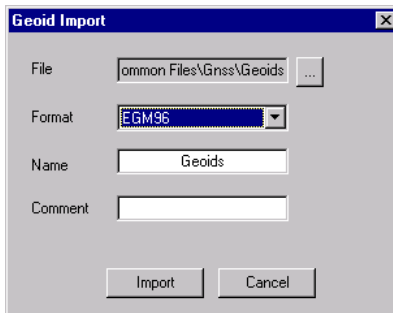
- After setting a port, click **OK** to upload the geoid file.

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.

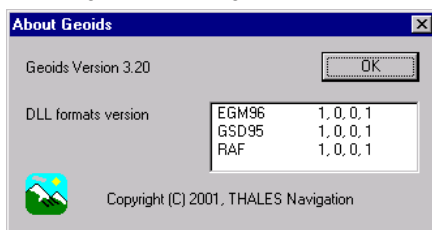
Example of Import dialog box:



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.



11. DTR Utility

Introduction

DTR is used to convert Thales-formatted raw data files into Observation + Navigation files in RINEX format.

❑ Input files

Input files should be Thales 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 Thales 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 « 0 » for Observation file, or « N » for Navigation file.

Using DTR

□ Description of the main window

These 3 fields are preset automatically upon selection of the file to be converted

Enter the path & name of the file to be converted in this field. Use the button to the right of this field to find the file on the computer disk

Optional parameters which are normally present in the header of a RINEX file. As they are not present in the THALES format, if you define them now in these fields, they will be inserted into the RINEX file when converting the file. When you are ready, click on the Run... button to convert the input file

For data time-labeling (see next page)

Check this button to name output files according to RINEX conventions. Then choose manually the file index (from 0 to 9) in the combo box which then appears on the right

DTR 4.00

THALES INPUT FILE

Raw Data File: C:\MY PROJECTS\RAWDATA*.*

Recorded On: nov 14, 2001

Marker Name: SITE

Observer Name: THOMAS

Receiver Number: 1003

Antenna Number: ANT0845

File Format: THALES BINARY

Marker Number:

Observer Agency: TOPSURV

Receiver Type: VERS 2

Receiver Version: 6502

Antenna Type: NAP002

RINEX OUTPUT FILES

Observation File: C:\MY PROJECTS\RAWDATA*.ALU

Navigation File: C:\MY PROJECTS\RAWDATA*.ZIN

Automatic naming according to RINEX conventions

Advanced... (Tr = Ts + 10 ms, using instantaneous dopplers) Go... Close

RINEX OUTPUT FILES

Observation File: C:\MY PROJECTS\RAWDATA\SITE3190.010

Navigation File: C:\MY PROJECTS\RAWDATA\SITE3190.01N

Automatic naming according to RINEX conventions

File Index: 0 [1st session of day]

1 [1st session of day]

2

3

4

5

6

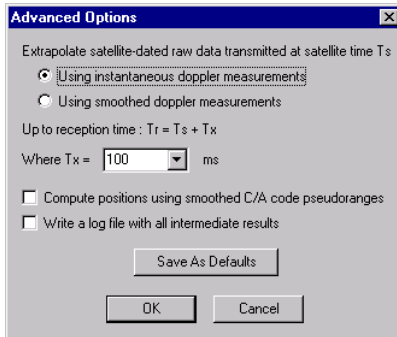
7

8

9

❑ 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 $T_x=0$.

To optimize further processing of files in RINEX format originating exclusively from THALES log files, use $T_x=75$ ms preferably. In addition, to optimize static processing, choose filtered dopplers preferably.

NOTE : 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. ♣

12. Appendices

Database in a Land Survey Project

□ Areas collection

Each object in the collection has the following attributes:






 Geocode1	Free geographic code 1
 Geocode2	Free geographic code 2
 Geocode3	Free geographic code 3
 Geocode4	Free geographic code 4
 Comment	Area description

+ a geometric attribute comprising:

- Geometry type: area
- Dimension: 3-dimensional
- Spatial Reference System in which the coordinates are expressed

□ Lines collection

Each object in the collection has the following attributes:

























 Geocode1	Free geographic code 1
 Geocode2	Free geographic code 2
 Geocode3	Free geographic code 3
 Geocode4	Free geographic code 4
 Comment	Line description

+ a geometric attribute comprising:

- Geometry type: line
- Dimension: 3-dimensional
- Spatial Reference System in which the coordinates are expressed

□ Points collection

Each object in the collection has the following attributes:









	Name	Point name
	Type	Point Type
	Geocode1	Free geographic code 1
	Geocode2	Free geographic code 2
	Geocode3	Free geographic code 3
	Geocode4	Free geographic code 4
	Comment	Point description
	Target_Easting	Target coordinate
	Target_Northing	Target coordinate
	Target_Height	Target coordinate
	Control_Type	Control type for error measurement
	Status	Status
	Fixed	Fixed status
	T	Time of solution
	Offset_Mode	Offset Mode
	P1P	Distance between P1 and P (m)
	P2P	Distance between P2 and P (m)
	Side	Lateral offset side
	Use	Indicates wheather point is involved in the local geode...
	Horizontal_Pr...	Horizontal 95 % confidence (m)
	Vertical_Preci...	Vertical 95% confidence (m)
	Horizontal_Error	Horizontal error between surveyed and target positions...
	Vertical_Error	Vertical error between surveyed and target positions (m)
	Total_Error	Total error according to control type (m)

+ a geometric attribute comprising:

- Geometry type: point
- Dimension: 3-dimensional
- Spatial Reference System in which the coordinates are expressed

□ **Files collection**

Each object in the collection has the following attributes:









 Name	File name
 Source	Source file format
 Site	Default site name
 Antenna_Height	Default antenna height
<input checked="" type="checkbox"/> Dynamic	Indicates whether the receiver has been moved during...
 Start_Time	Time of first record
 Time_Span	Record duration
 Sampling	Sampling interval (s)
 SVs	Tracked satellites
<input checked="" type="checkbox"/> Navigation	Indicates the presence of navigation data for the track...

+ a geometric attribute comprising:

- Geometry type: point
- Dimension: 3-dimensional
- Spatial Reference System

□ **Processes collection**

Each object in the collection has the following attributes:











 Number	Process number in 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
<input checked="" type="checkbox"/> L1L2	Indicates whether L2 data have to be process or not
<input checked="" type="checkbox"/> Fix_Integers	Indicates whether process have to fix integers or not

+ a geometric attribute comprising:

- Geometry type: line
- Dimension: 3-dimensional
- Spatial Reference System











































□ Stops collection

Each object in the collection has the following attributes:

	Start_Time	Start time of occupation
	Time_Span	Time span of occupation
	Name	Point name
	Geocode1	Free geographic code 1
	Geocode2	Free geographic code 2
	Geocode3	Free geographic code 3
	Geocode4	Free geographic code 4
	Comment	Point description
	Raw_data_file	Raw data file
	Antenna_Height	Default antenna height

□ Vectors collection

Each object in the collection has the following 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
<input checked="" type="checkbox"/>	Enabled	Indicate wheather solution is to be kept for adjustment
	DX	Processed ECEF WGS84 DX component (m)
	DY	Processed ECEF WGS84 DY component (m)
	DZ	Processed ECEF WGS84 DZ component (m)
	Length	Processed length
	SdX	Processed ECEF WGS84 DX standard deviation (m)
	SdY	Processed ECEF WGS84 DY standard deviation (m)
	SdZ	Processed ECEF WGS84 DZ standard deviation (m)
	RXY	Processed ECEF WGS84 XY correlation
	RXZ	Processed ECEF WGS84 XZ correlation
	RYZ	Processed ECEF WGS84 YZ correlation
	RMS	Processed Root Mean Square
	UV	Processed solution unit variance
	Epochs	Number of epoch used in process
	SVS	Minimum number of satellites during process
	PDOP	Maximum PDOP during process
	From_Antenn...	Used antenna height at station
	To_Antenna_...	Used antenna height at rover
<input checked="" type="checkbox"/>	Adjusted	Indicated wheather this vector has been adjusted
	Adjusted_DX	Adjusted ECEF WGS84 DX component (m)
	Adjusted_DY	Adjusted ECEF WGS84 DY component (m)
	Adjusted_DZ	Adjusted ECEF WGS84 DZ component (m)
	Adjusted_Len...	Adjusted length
	Adjusted_SdX	Adjusted ECEF WGS84 DX standard deviation (m)
	Adjusted_SdY	Adjusted ECEF WGS84 DY standard deviation (m)
	Adjusted_SdZ	Adjusted ECEF WGS84 DZ standard deviation (m)
	Adjusted_RXY	Adjusted ECEF WGS84 XY correlation
	Adjusted_DZ	Adjusted ECEF WGS84 DZ component (m)
	Adjusted_Len...	Adjusted length
	Adjusted_SdX	Adjusted ECEF WGS84 DX standard deviation (m)
	Adjusted_SdY	Adjusted ECEF WGS84 DY standard deviation (m)
	Adjusted_SdZ	Adjusted ECEF WGS84 DZ standard deviation (m)
	Adjusted_RXY	Adjusted ECEF WGS84 XY correlation
	Adjusted_RXZ	Adjusted ECEF WGS84 XZ correlation
	Adjusted_RYZ	Adjusted ECEF WGS84 YZ correlation
	Adjusted_RMS	Adjusted Root Mean Square
	DX_Residual	ECEF WGS84 DX component residual (m)
	DY_Residual	ECEF WGS84 DY component residual (m)
	DZ_Residual	ECEF WGS84 DZ component residual (m)
<input checked="" type="checkbox"/>	Tau_Test	Tau test ?

+ a geometric attribute comprising:

- Geometry type: line
- Dimension: 3-dimensional
- Spatial Reference System in which all coordinates are expressed.


















□ **Broadcast_Ephemeris collection**

Each object in the collection has the following attributes:

 T	Reference time of ephemeris
 SV	Satellite PRN Number [1..32]
 Health	Satellite Health Status (0 = Good)
 URA	User Range Accuracy (m)
 IDDE	Issue Of Data, Ephemeris : Version Number for Ephem...
 Validity	Validity Duration for Navigation Data (h)
 SqrtA	Square Root of Semi-Major Axis (m ^{1/2})
 E	Orbit Eccentricity (dimensionless)
 IO	Orbital Inclination Angle at Reference Time (rd)
 IDOT	Orbital Inclination Angle Drift (rd/s)
 Omega	Right Ascension at Reference Time (deg)
 Omega_Dot	Right Ascension Drift (rd/s)
 w	Argument of Perigee (rd)
 M0	Mean Anomalie at Reference Time (rd)
 Delta_N	Mean Motion Difference From Computed Value (rd/s)
 Cuc	Amplitude of the Cosine Harmonic Correction Term to t...
 Cus	Amplitude of the Sine Harmonic Correction Term to the...
 Crc	Amplitude of the Cosine Harmonic Correction Term to t...
 Crs	Amplitude of the Sine Harmonic Correction Term to the...
 Cic	Amplitude of the Cosine Harmonic Correction Term to t...
 Cis	Amplitude of the Sine Harmonic Correction Term to the...
 Toc	Time of Clock : Reference Time for SV Clock Data
 IDDC	Issue Of Data, Clock : Version Number for Clock Data
 Af0	Satellite Clock Bias (s)
 Af1	Satellite Clock Drift (s/s)
 Af2	Satellite Clock Drift Rate (s/s ²)
 TGD	L1-L2 correction term for single-frequency users
 Code_On_L2	Indicates whether L2 is modulated by P (1) or C/A (2)
 L2_Data_Flag	Indicates whether code P is modulated by Navigation



















□ **Broadcast_Iono collection**

Each object in the collection has the following attributes:

 T	Reference Time of Ionospheric Parameters
 Alpha0	Ionospheric Correction Parameter Alpha0 of Almanac (s)
 Alpha1	Ionospheric Correction Parameter Alpha1 of Almanac (...)
 Alpha2	Ionospheric Correction Parameter Alpha2 of Almanac (...)
 Alpha3	Ionospheric Correction Parameter Alpha3 of Almanac (...)
 Beta0	Ionospheric Correction Parameter Beta0 of Almanac (s)
 Beta1	Ionospheric Correction Parameter Beta1 of Almanac (s...
 Beta2	Ionospheric Correction Parameter Beta2 of Almanac (s...
 Beta3	Ionospheric Correction Parameter Beta3 of Almanac (s...
 WNT	Reference Week Number for UTC data
 Tot	Reference Time of week for UTC Data (s of week)
 Delta_TLS	GPS-UTC Delta Time due to Leap Seconds (s)
 A0	Polynomial Coefficient A0 for fine UTC time computatio...
 A1	Polynomial Coefficient A1 for fine UTC time computatio...
 WNLSF	GPS Week Number for the Next Change in UTC data
 DN	GPS Day of Week for the next change in UTC data
 Delta_TLSF	Future GPS-UTC Delta Time due to Leap Seconds aft...

□ **GPS_Measurements collection**

Each object in the collection has the following attributes:

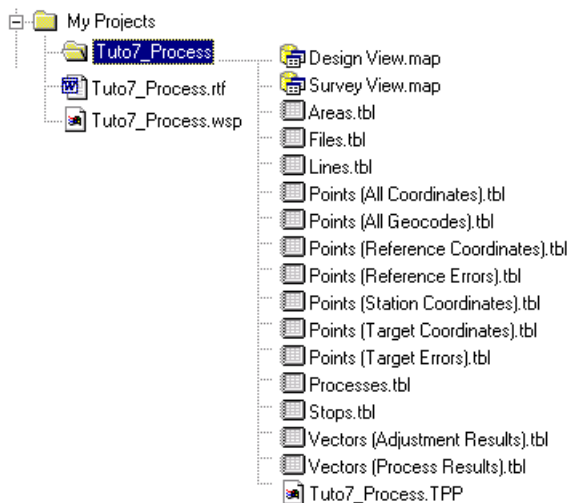
 Epoch	Epoch Index
 T	Time of Record
 RCE	Receiver Clock Error
 SV	Satellite PRN Number
 C1	Pseudo Range measurement using C/A on L1 (m)
 DQIC1	Data Quality Indicator for C1 measurement
 CNOC1	Signal Strength measurement for L1 C/A (db.Hz)
 L1	Carrier measurement using C/A on L1 (cycles)
 DQIL1	Data Quality Indicator for L1
<input checked="" type="checkbox"/> LCIL1	Loss of Continuity Indicator for L1
 CLCIL1	Cumulative Loss of Continuity Indicator for L1
 D1	Doppler measurement using C/A on L1 (cycles/s)
<input checked="" type="checkbox"/> Antispoofing	Indicates whether code P is crypted as Y or not
 P1	Pseudo Range measurement using P/Y on L1 (m)
 P2	Pseudo Range measurement using P/Y on L2 (m)
 DQIP2	Data Quality Indicator for P2 measurement
 L2	Carrier measurement using P/Y on L2 (cycles)
 DQIL2	Data Quality Indicator for L2
<input checked="" type="checkbox"/> LCIL2	Loss of Continuity Indicator for L2
 CLCIL2	Cumulative Loss of Continuity Indicator for L2
 D2	Doppler measurement using P/Y on L2 (cycles/s)

Created Files & Directories

❑ Creating a New Project in a New Workspace

The project and the workspace then have the same name.

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. These files are in fact the default documents listed on the **Documents** tab of the Workspace pane. Below is a project structure example, as seen from Windows Explorer:



Where:

- *.map: map documents
- *.tbl: table documents
- *.gph: graph documents
- *.TPP: Project database
- *>.rtf: RTF file containing the text displayed in the Output pane for the project (messages, processing reports, etc.)
- *.wsp: file containing the current settings of 4SPack main window for this workspace. ♣

Glossary

- Blunder:** Error made by the field operator during the survey causing glaring errors in survey results. Not to be confused with uncertainties in system measurements
- 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
- Datum:** An ellipsoid that is offset with respect to a reference ellipsoid (usually the WGS84). A datum is therefore fully defined by providing the following parameters: an ellipsoid definition, datum shifts (i.e. angular & linear components of the spatial deviation between the center of the ellipsoid and that of the reference ellipsoid) and a scale factor
- Ellipsoid:** A mathematical representation of the Earth as an ellipse that is rotated about its minor axis. An ellipsoid is fully defined by providing the following two parameters: semi-major axis and inverse of flattening
- Geographic System:** A coordinate system based on the definition of a datum
- Intermediate Point:** Any point in a trajectory

- Logged Reference: A reference (or control) point, other than the planned ones, surveyed by a field operator
- Logged Point: A point, other than the planned ones, surveyed by the field operator
- Planned Reference: A reference (or control) point with already surveyed coordinates. Creating such a point in a project means that you wish the field operator to re-survey that point for cross-checking purposes
- Planned Target: A point whose coordinates are provided by the project. This point is not materialized in the field. Creating such a point in a project means that you wish the field operator to get to this point, guided by her/his equipment, to place a stake on that point. In the same time, the field operator will be prompted to log the position solution computed by the equipment on that point.
- Staked-Out Target: A target point, which the operator visited, guided by his/her equipment, to place a stake and to record the position computed in real-time by this equipment.
- Station: The position of a point from which corrections data is transmitted to be used by operators working in the field.