GPS Manager User Manual

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Contents

Chapter 1

Introduction

GPS Manager (GPSMan) is a graphical manager of GPS data that makes possible the preparation, inspection and edition of GPS data in a friendly environment. GPSMan supports communication and real-time logging with both Garmin and Lowrance receivers and accepts real-time logging information in NMEA 0183 from any GPS receiver.

GPSMan is a stand-alone Tcl/Tk program. Its use in real-time is at the sole risk of the user. In particular, the use of a laptop computer while driving alone is extremely dangerous.

The version available on 5 February 2002 is number 5.4.2. This software is under copyright (2002) by Miguel Filgueiras and Universidade do Porto, with the contributions listed below under copyright by their authors. See below (C) for a list of new features.

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1.1 Contributors

GPSMan incorporates code contributed by

- Brian Baulch (baulchb@hotkey.net.au): communication with Lowrance receivers, support for the wheelmouse, real-time logging (variant for the Lowrance);
- Rogério Reis (Universidade do Porto): Debian Linux package and the utilities to configure and lock the serial port;
- Andreas Lange (andreas.lange@rhein-main.de): support for German;
- Alessandro Palmas (alpalmas@tin.it): implementation of elevation graphs for tracks and routes, and support for Italian;
- Niki Hammler (http://www.nobaq.net): Perl script for reading waypoint data in Fugawi export format which was translated into Tcl and incorporated in GPSMan;
- Martin Ostermann (Aachen University of Technology): conversion of waypoints listed in HTML pages of the MapBlast site into GPSMan data;
- Valère Robin (valere.robin@wanadoo.fr): support for French;
- David Wolfskill (david@catwhisker.org): FreeBSD package;
- Rob Buitenhuis (rob@buitenhs.demon.nl): support for Dutch;
- Frank Kujawski (Frank@Kujawski.org): conversion of routes listed in HTML pages of the MapsOnUS site into GPSMan data.

Help from many other people should be mentioned and is acknowledged below (5.2).

1.2 Main features

What GPSMan does:

- GPSMan keeps lists of waypoints, routes and tracks, whose information can be written to and read from text files, or got from and put into supported GPS receivers;
- GPSMan lets the user create new waypoints, routes and tracks, as well as modify or delete those already defined;
- GPSMan lets the user create, modify and delete groups (sets) of waypoints, routes, tracks and other groups; groups are very helpful in keeping and classifying the existing information, as well as in the selection of information to be processed;
- GPSMan makes conversions of
  - routes into tracks;
  - tracks into routes, by keeping a certain number (fixed by the user) of track points;
  - tracks into a waypoint taking the averages of the latitudes, longitudes and altitudes of the track points;
  - waypoints in a group into a waypoint taking the averages of their latitudes, longitudes and altitudes;
- GPSMan records real-time track logging information that can be displayed on a moving map and used to create a track (that may be then converted into a route);
- GPSMan makes computations of,
  - for waypoints: distance and bearing to another waypoint, nearest waypoints (in fact, distances and bearings to all other waypoints ordered from nearest to furthest), clusters of waypoints with given centres,
  - for routes: distances, azimuths and differences in altitude between consecutive points, total distance, and enclosed area (under certain conditions),
  - for tracks: distances, differences in time, speed and azimuths between consecutive points, cumulative distance and altitude at each point, total distance and average speed for the track, distance from first to last point, maximum distance from first point to any track point;
- GPSMan can make a map to scale, using one of a choice of projections, of waypoints, routes and tracks; the map can be saved as a Postscript file for printing or further processing; images may be used as background for the map and geo-referenced; waypoints can be represented in different ways (any combination of symbol and name or comment); an animation of the movement along the real-time track or of a recorded track can be shown on the map; elevation graphs of routes and tracks can be plotted and saved as Postscript files;
- GPSMan allows for data items to be searched by:
  - patterns matching the item name, comment and/or remark,
  - distance to a given waypoint or location (given by its coordinates), for waypoints and tracks,
  - symbol, for waypoints,
  - waypoints, for routes,
  - start date, for tracks.

- GPSMan provides conversion between different position formats (latitude/longitude in DMS, DMM or DDD, and some grid coordinates, including UTM/UPS) and/or different datums; there is support for user-defined datums, ellipsoids, projections and related coordinate grids.

- GPSMan allows the user to change its configuration, providing a choice of languages (Dutch, English, French, German, Italian and Portuguese in the current distribution), and accepting new values for parameters related to the GPS receiver, default settings, and concerning interface appearance (colours, dimensions, positions).

Chapter 2

Programs

2.1 Current version

The current version is: GPSMan version 5.4.2, a stand-alone Tcl/Tk program that communicates directly with the GPS receiver.

2.2 Known problems

The list of known problems (on 5 February 2002) is:

1. GPSMan relies on the use of a serial port to communicate with the GPS receiver. Some Tcl/Tk installations (e.g., in SuSe, Red Hat and Mandrake Linux distributions), operating system drivers and even hardware (in some laptops) were reported not to work correctly with the serial port. Namely, the Tcl error: "bad option -mode" is a problem of bad configuration of the Tcl/Tk installation and upgrading to a newer version normally solves the problem. To help debugging input from a serial port a Tcl/Tk program is available from the WWW page at `http://www.ncc.up.pt/~mig/gpsman.html`. It must be edited before use to set the correct path to the serial port.

2. GPSMan support for Garmin receivers may need to convert between bytes and floating point numbers. Tcl/Tk has no machine-independent way to do these conversions and GPSMan only implements them for little- or big-endian architectures that follow the IEEE floating point standard. Some Garmin receivers do not use protocols having floating point numbers and are not affected by this.

3. GPSMan releases 5.3 and later cannot be run under Tcl/Tk 8.0 due to bugs in the latter. The recommended version of Tcl/Tk is 8.3 or later.

4. in older Tcl/Tk versions, neither map background images nor waypoint symbols are saved to Postscript along the other map information. Upgrading to a more recent Tcl/Tk is highly recommended.

5. due to limitations imposed by Tcl/Tk, that does not implement communication with serial ports on Macintosh platforms, GPSMan will not be able to dialog with the GPS receiver on these systems.

2.3 Downloading

2.3.1 GPSMan

GPSMan (version 5.4.2) is available for downloading from the address `http://www.ncc.up.pt/~mig/gpsman.html`. Both Debian, Slackware, RPM and FreeBSD packages are available for easy installation in Linux. Updates for the current release can also be found there.

In order to run GPSMan, Tcl/Tk (version 8.2 or later; 8.3 is recommended) must be previously installed. It can be got from the Active State site at `http://tcl.activestate.com`.

2.3.2 Conversion of MapBlast waypoints

A separate program to convert the waypoints listed in HTML pages of the MapBlast site into GPSMan files is also available under the name of `mb2gmn.tcl`. At its core is code contributed by Martin Ostermann (Aachen University of Technology). The reason why this code was not integrated into GPSMan is that the format of those HTML pages does not follow any known specification and may change at any time.

In order to run `mb2gmn.tcl` GPSMan must be installed as they share some source files. After downloading, the file `mb2gmn.tcl`, which can be found in the `util` directory, should be edited for configuration.

To use this program HTML pages produced at the MapBlast site in answer to queries under the `Directions` section should be saved locally and then opened from the program.

2.3.3 Conversion of MapsOnUS routes

A separate program to convert the routes listed in HTML pages of the MapsOnUS site into GPSMan files is also available under the name of `mou2gmn.tcl`. At its core is code contributed by Frank Kujawski (Frank@Kujawski.org). The reason why this code was not integrated into GPSMan is that the format of those HTML pages does not follow any known specification and may change at any time.

In order to run `mou2gmn.tcl` GPSMan must be installed as they share some source files. After downloading, the file `mou2gmn.tcl`, which can be found in the `util` directory, should be edited for configuration.

This program works on HTML files created at the MapsOnUS site as follows: go to the "General Options" (under the "Tools" menu), select "Show Latitude & Longitude", plan a route, "jump to turn-by-turn directions", hit the "non-tabular format" link and save locally the HTML page. These files are then opened from the program and the resulting files will contain the routes and their waypoints. The remark fields of the waypoints will have the directions in the HTML pages.

2.4 Data and examples

The following data and examples are available at the same address:

- data concerning some paragliding sites in Portugal,
- track file for one sample flight,
- computation results for that track, and,
- a map of the same track, in GIF or Postscript.

2.5 Installation

In Unix and Linux systems access to the serial port is restricted. This means that either there is a program to lock the port with super-user privileges, or the permissions of the port are changed to give read/write access to a group of users or to all users. The latter is dangerous in that it creates security problems. In any case super-user privileges are needed to install the software or to give access to the serial port group.

2.5.1 Debian and Slackware packages

The installation is done as with other such packages and there is no need for configuration. Users of GPSMan must belong to the group that owns the serial port to be used (normally `dialout`).

The program is launched by calling `gpsman` that may have as single argument the path to the serial port device.

2.5.2 Other Unix and Linux systems

After unpacking the files, using `tar xzvf gpsman-5.4.2.tgz`, the GPSMan main file, `gpsman.tcl`, should be edited for configuration (see below (3)) and put where it can be executed. The other GPSMan files should go into the directory whose path is given in the beginning of `gpsman.tcl`.

The package includes a file `gpsman.sh` in the `util` directory that is a shell script to call `gpsman.tcl` with no need to give the serial port as argument. This file should be edited for configuration and placed where its can be executed.

A directory `aux` is created that contains the source of utilities to lock and set the serial port. These utilities, that need the `liblockdev` library, must be run with super-user privileges. One is `gpsman` that tries to lock the serial port and calls the Tcl/Tk program `gpsman.tcl` passing the path of the serial port to it as an argument. The other one is `gpsman-config` that sets the path of the serial port to be used. This path is stored in the file `/etc/gpsman`.

2.5.3 Other systems

After unpacking the `gpsman-5.4.2.zip` archive the GPSMan main file, `gpsman.tcl`, should be edited for configuration (see below (3)) and put where it can be executed. The other GPSMan files should go into the directory whose path is given in the beginning of `gpsman.tcl`.

Chapter 3

Configuration

A lot of parameters may be configured in the GPSMan main file `gpsman.tcl`, most of which are also defined in the preferences file.

GPSMan needs a user directory to keep both the preferences file and other files for user definitions (like user-defined projections). The path to this directory and the name of the preferences file are given at the beginning of `gpsman.tcl`. When GPSMan is launched and does not find the user directory, it either attempts to create it, or (in non-Unix systems) asks for it to be created and leaves. If the preferences file does not exist, it forces it to be created.

Therefore the configuration in `gpsman.tcl` only sets the defaults that will be presented at that time, as well as the values for parameters not set in the preferences file.

Users wanting to load their own Tcl/Tk code (at their own risk!) can do so by putting it in a file named `patch.tcl` in the GPSMan user directory. This file will be loaded immediately after all the GPSMan source files.

If GPSMan has been installed from the Debian or Slackware packages no changes are mandatory. Otherwise, on Unix systems the information on the program source files directory, user directory and default preferences file must be correctly set. A default serial port device can be defined and will be used if no argument is passed to the main program.

On other systems the same applies to the information on the serial port.

- for non-Unix systems: serial device to which the receiver will be connected; users of GPSMan must have read/write permission.
- path to directory containing the program source files.
- path to user directory that will contain the preferences file and other files for user definitions (like user-defined projections); this directory is normally not to be used explicitly by the user.
- name of the preferences file; the user directory is searched for it only if there is not a file under the same name in the current directory.
- the language to be used by GPSMan; new languages can be included by translating the `lang*.tcl` files that contain the text and messages in English, German, Italian and Portuguese (help here will be acknowledged) and inserting new abbreviations for month names in the `ALLMONTH` array.
- use of character composition (accents, cedilla) using Western European (isolatin1) mode, and of `Delete` key to delete last character.
- choice of main window: there are three permanent windows for the map, lists, and receiver connection; either the map or the lists window can be selected as being the main window.

- GPS receiver dependent values: GPS brand, length of names, comments, maximum numbers of waypoints, routes, waypoints in routes, and track points, use of creation dates and of lowercase letters in strings. In the distribution, the values are set for use with a Garmin GPS II.
- (for Lowrance receivers only) sampling interval, in seconds, when acquiring tracks.
- default symbol and default display option to use with waypoints; correct names for symbols and display options can be found in file `symbols.tcl`.
- when displaying a track, count of track points before showing point number; 0 means no numbers, 1 means all points numbered, 2 every other point numbered, and so on.
- behaviour when reading a data item with the same name as another item of the same type in the data-base: either overwrite the existing one, or create under a new name.
- behaviour when a data item with hidden information is changed: remove the hidden information, keep it, or ask the user.
- distance unit to be used.
- format of positions, default datum and time offset, date format.
- accurate formulae (slower than the normal ones) for computing distances and bearings.
- whether to ask for confirmation of projection parameters.
- map dimensions, length of line for displaying a scale, and initial map scale given as the distance corresponding to the given line length. The possible values for this distance depend on the choice of unit made before.
- interface appearance: number of maximum elements per menu, initial positions of windows, dimensions, colours.
- saving the program state on exit and deleting the saved state files after restoring
- permission of created files (in Unix numeric notation).
- abbreviated names for months in all known languages.
- paper sizes and dimensions, used when saving plots or maps as Postscript files. The dimensions are floating-point numbers followed by `c` for centimeters, `i` for inches, `m` for millimeters, or `p` or nothing for printer's points (1/72 inch).

Chapter 4

Using GPSMan

4.1 Launching GPSMan

If GPSMan was installed from the Debian or Slackware packages, just call `gpsman` from a shell or from the applications menu of the window manager (if it was set up by the Debian installation). A single argument can be given with the path to the serial port device.

In other Unix or Linux systems call `gpsman.tcl` from the shell, possibly with the path to the serial port device as an argument, or use the shell script `gpsman.sh` (it must be configured first).

In other systems, execute `gpsman.tcl` with the Tcl/Tk `wish` program.

4.2 Terminology

Here is a list of a few terms that will be used below.

Waypoints, routes, and tracks are examples of data used in GPS receivers. A waypoint (sometimes abbreviated to WP) describes a precise location through its geographic coordinates. A sequence of waypoints is called a route (RT) and is defined by the user. A track (TR, also called a trail in Lowrance receivers) is a sequence of track points (TPs) recorded by the GPS receiver over a time period and giving the positions of the receiver during that period, and including if possible the altitude and the depth (in meters).

Route stages are the parts of a route between each two consecutive waypoints. Route stages are called *edges* in Graph Theory, *legs* in aviation, and *links* by Garmin. At present, GPSMan deals with three data fields for each stage: a comment, a label (that will appear in the map), and hidden information.

Data items refer to the elements stored in the GPSMan data-base. Apart from data items the GPS receivers use, groups (GRs) of such items can be defined and used.

Forgetting a data item means deleting it permanently from the data-base.

Input/Output operations in GPSMan have the following names (see below for the definitions of the GPSMan file formats):

- *loading* from and *saving* to files in GPSMan format;
- *getting* from and *putting* into the GPS receiver (this corresponds to the terms *downloading* and *uploading*, respectively, used in other software);

- *importing* from and *exporting* to files in a foreign format. Currently recognized formats: GPStrans, and Fugawi export format (this one only for importation of waypoints).

A unique name is used for each item of each type. When a new item is read in that has the same name as an item of the same type in the data-base, either the latter is forgotten, or the new item gets a new name, according to an option. Choosing to forget the previous item is recommended as it is the behaviour of most GPS receivers, and because this will avoid having obsolete information in the data-base. Obviously it should be noted that in this case all input operations are *destructive*: new items will replace data-base items having the same name.

Irrespective of the selected option, replacement is always done when the items with the same name are waypoints with exactly the same position. Note however that the test for the positions being the same may fail because of rounding errors when the comparison implies a change of position format or a change of datum.

When an item is renamed, its previous name is kept in the remark field.

Allowed characters in names of waypoints depend on the brand of the receiver. Garmin names can only have uppercase letters and digits, even if Garmin receivers may use others (see the Garmin specification...). GPSMan also accepts lowercase letters if the existing option on this was set by the user, and hifens. Lowrance names can have uppercase letters, digits, hifen, single quote, period, parentheses, slash and also space. If data files are to be shared among users with receivers of different brands, the more strict rules (those of Garmin, at present) should be followed.

When a name with characters not allowed is read from a file or from the receiver, the user is asked for a new name. A name of a waypoint already in the data-base will not be accepted. Cancelling the renaming makes the waypont to be ignored, what may cause inconsistency if it belongs to a route.

Comments and remarks (NB) can be specified for some items. The difference is that comments can be got from and put into the GPS receiver, while remarks are only kept by the interface and may be saved to and loaded from GPSMan files. The syntax for comments depends on what the receiver accepts. The syntax for remarks is free: any ASCII character, any length, although no blank lines are allowed.

4.3 Data

The contents of the GPSMan data-base are shown in lists, one per each item type. Item names, which are unique, are presented in alphabetical order.

List menus contain the actions allowed on the list: creating a new item, clearing the list, reading/writing items, and counting the number of items in the list. The menu for the groups list is a little different and is described below (4.7).

Loading operations read all the data in a GPSMan file irrespective of from what menu the operation was launched.

To open an item for editing (only possible when no other item of the same kind is being edited) or viewing its data, use double-click on the item name with the mouse left-button. Double-clicking also works with the same meaning on other lists of item names, as well as on graphical representations of items in the map window.

An edit/show window for an item will be re-opened in case there is a read operation redefining it.

To display/clear an item on/from the map click on the item name (in the corresponding list) with the mouse right-button, or use the `Clear` menu-button on the map window.

A read operation redefining items that are currently on the map will cause the map to be updated in order to keep it consistent with the new definitions.

Pressing a key on a list will scroll it to make visible the first element whose initial character is the same or higher in ASCII order than the key character. Note that this is case sensitive (i.e., `a` is not `A`). This also works on lists presented for choosing items. Lists can be scrolled by moving the wheel of a wheelmouse.

Hidden information is kept (in the data-base and in files) associated to a data item that has been read in (from a file, or from the receiver) when that information cannot be displayed and edited using GPSMan. This is done mainly with data fields that are not of general use, and provides a means of restoring the data item back to any receiver that works with the same communication protocols, without loosing information. When such a data item is modified its hidden information is either deleted, or kept, or acted upon as the user sees fit, according to an option. Keeping the hidden information may cause incoherent items to be created and therefore should be used with care.

Saving the program state when exiting is controlled by an option that may inhibit this feature, do the saving if the user confirms it, or do it without asking. When saving the state, files in the user data directory are created that contain the current data-base, the map state and information on which edit/show windows are currently being used. No information is kept on

1. the state of the communication with the receiver
2. the changes in pending edit operations or items partially defined
3. the state of computation, elevation, and real-time log windows.

The saved state is automatically loaded when GPSMan is launched and detects a saved state file in the user directory. There is an option to control whether to delete saved state files after the state being restored; it can be set in the same way as the save state option. In any case GPSMan automatically overwrites saved state files when saving a new state, and it is therefore a good idea to save important data to a file before quitting the program.

4.4 Waypoints

A position format and a datum for presenting the position of each waypoint are chosen by the user. Changing the format or the datum may be made at will, but too many conversions may degrade the accuracy of the data.

The position formats of all the waypoints in a group can be changed in a single operation as described below (4.7). The same applies for datums as described below (4.7).

Some information that may be relevant for choosing a datum is given when describing how to define new datums (4.11).

The following position formats can be used:

- `DMS` for degrees followed by minutes, both as integers, followed by seconds as a floating point number;
- `DMM` for degrees as integer followed by minutes as a floating point number;
- `DDD` for degrees as a floating point number;
- `UTM/UPS` for easting zone number, northing zone letter, easting and northing of Universal Transverse Mercator or Universal Polar Stereographic coordinates.

- one of the available grid systems, either pre-defined or user-defined, with a zone identifier (void for some grids), a easting and a northing (both in metres by default; user-defined ones may be in feet). The pre-defined grids are:
  - `BNG`: British National Grid
  - `BWI`: British West Indies grid
  - `CMP`: Portuguese military maps grid
  - `GKK`: German grid ("Gauss-Krueger-Koordinatensystem")
  - `ITM`: Irish Transverse Mercator
  - `KKJP`: basic Finnish grid
  - `KKJY`: uniform Finnish grid
  - `SEG`: Swedish grid.
  - `TWG`: Taiwan grid.

  More details on these grids can be found below (4.12).
- `MH` Maidenhead locator coordinates: this is a special kind of grid used mainly for specifying the position of radio stations, each smallest subdivision being 5 minutes in longitude and 2.5 minutes in latitude. This means that conversions from other position formats to this one will most probably loose accuracy.

The altitude for a waypoint is given as a (possibly signed) floating point number in metres.

A symbol and a display option are also chosen for each waypoint. GPSMan symbols and display options may not all be supported by the receiver. When GPSMan is aware of this a tilde ~ will appear before the symbol name in the symbols menu. Symbols and display options not supported will be transmitted to the receiver as the default values; if these are also not supported, the symbol will be transmitted as a waypoint dot, and the display option as "Symbol & name". GPSMan will obviously not transmit this information to receivers not supportting it.

A waypoint can be created from the map , if the map has been geo-referenced: see below (4.9)

The position of a waypoint displayed on the map can be changed there through a menu, as described below (4.9).

A waypoint can be created from a track , either as one of its points, or by taking an average of the coordinates: see below (4.6).

A waypoint can be created from the waypoints in a group by taking an average of the coordinates: see below (4.7).

Clusters of waypoints can be created by giving a group of waypoints to be used as centres: see below (4.7).

4.5 Routes

Routes may happen to have waypoints that were permanently deleted by the user (`Forget` button in waypoint window). In this case the values of distances and bearings for such points and the total distance will not be shown. Saving, exporting or displaying a route with undefined waypoints will be prevented with a warning.

A route can be created from a track : see below (4.6).

A route can be changed or created by drawing on the map as explained below (4.9).

To change a route stage a double-click with the mouse left-button should be made on one of the stage fields in the route edit window. An edit window will pop up that must be used and closed before going on.

Changes in a waypoint belonging to a route being edited/inspected will be reflected in the route window.

When modifying a route the coherence of its waypoints and its stages cannot be checked by GPSMan. For instance, when adding a new waypoint after another one the stage starting from the latter is not affected, and when replacing a waypoint by another one the stages ending on and starting from it are not affected.

The edit window for routes allows some operations on routes that may be useful. They are:

- "Invert": take the route from the last to the first waypoint;
- "Chop head": all waypoints from the first to and including the one selected are deleted; if there is no selection the first waypoint is deleted;
- "Chop tail": all waypoints from and including the one selected to the last are deleted; if there is no selection the last waypoint is deleted;
- "Include before", or "Include after": include the route (whose number was selected in the sub-menu) before or after the selected waypoint; if there is no selection, the inclusion will be done before the first or after the last waypoint, respectively.
- "Clear": delete all waypoints.

A route can be converted into a track from the route window.

An elevation graph for a route can be plotted from the route window and subsequently saved as a Postscript file if there are at least 3 waypoints with a valid altitude field.

The area enclosed by a route can be computed under the following conditions — badly wrong values will result if they are not met! The route stages are taken as sides of a polygon and if the last waypoint is not the same as the first, a "virtual" side from the first to the last waypoint is considered. The polygon must be non-intersecting: there can be no multiple occurrences of waypoints (apart from the first one being also the last) and no intersections of the polygon sides. GPSMan will only check for multiple occurrences of waypoints. The method for computing areas is an approximate method that is not reliable when there are sides of the polygon too small when compared to others or there are very small angles between the sides. Results of area computations should be used with care and if possible checked against results of other forms of area measurement.

The details of the area computation are as follows. An algorithm for computing the area of a (non-self intersecting) polygon on the sphere is first tried out. If there are very small intermediate values that may indicate approximation errors, the area is computed by first projecting the polygon onto the plane (using the Transverse Mercator projection centred at the first point of the polygon) and applying then an algorithm for computing the area of a (non-self intersecting) polygon on the plane. A warning message is issued if this happens.

4.6 Tracks

Each track point has the following information: time stamp, position, altitude and depth in meters. In the computation results there are six fields for each point: distance to next point, cumulative distance to next point, altitude in meters (a negative number means depth instead), time to next point, speed in the segment to the next point and bearing to the next point.

The edit window for tracks allows some operations on tracks that may be useful to clean uninteresting start or end segments of a track, or to compose a single track from several others. They are:

- "Chop head": all track points from the first to and including the one selected are deleted; if there is no selection the first track point is deleted;
- "Chop tail": all track points from and including the one selected to the last are deleted; if there is no selection the last track point is deleted;
- "Include before", or "Append": the track points of another track are put before the first, or after the last track point. To ensure sensible values for speed between track points, their dates may have to be changed. GPSMan will show the distance between the last point in the first track to the first point in the second and will propose a new date for this one. This date is computed assuming a constant speed and may be changed by the user. All dates in the second track will be adjusted according to the selected date, keeping the original differences.

An elevation graph for a track can be plotted from the track computation window and subsequently saved as a Postscript file if there are at least 3 track points with a valid altitude field.

Creating a waypoint from a track point can be done by double clicking with the mouse left-button on a track point listed in a track window. This will open, for edition, a new waypoint having the same coordinates unless there is already a waypoint being edited. If the track is currently on the map the number of each track point together with the track name will appear in the help balloon when the cursor is over the point.

A waypoint with average coordinates can be created from a track window. Its latitude, longitude and altitude will be computed as the averages of the latitudes, longitudes and altitudes of the track points. This will be useful for obtaining more precise coordinates for a waypoint by recording a track with the receiver standing still.

A track can be converted into a route by a simplifying algorithm that keeps a certain number of track points as waypoints of the new route.

The algorithm that was developed for this may be seen as a variant of the Douglas-Peucker algorithm for finding critical points in polylines (see, e.g.,[Heckbert and Garland, 1997] or [Li, 1995]). It starts from a straight line between the first and the last track points; if the number of points to keep is greater than 2, any point that stands furthest from the line will be retained, and the line is replaced by two new lines, those from the first to the new point and from it to the last one. This procedure is repeated always replacing one of the lines for which the distance to an intermediate point is maximum. The review of [Heckbert and Garland, 1997] describes an algorithm by Ballard and Brown (published in 1982) that seems to be very close to this one.

Although GPSMan lets the user fix the number of points to keep between 2 and the number of track points, there is a maximum number of points per route depending on the GPS receiver. It should also be noted that the time needed to find the route will increase significantly with the number of points (although keeping all the track points will take only the time to create the new waypoints).

So that a choice may be made between different numbers of points, GPSMan may be asked to display the route and also the track on the map on the fly. When the user clicks the `Ok` button, the map will be restored, new waypoints will be created (with names of the form `ZT`n, with n a 4-digit integer), and a window will be opened for editing the route with these waypoints.

This operation will fail if there is already a route being edited; however the new waypoints will not be deleted. GPSMan will create a new group with all the new waypoints for easier access.

An animation of the movement corresponding to a track can be viewed in the map window (`Animation` button in the track edit/show window). A control window will appear that allows for (re-)starting, pausing, or aborting the animation, for setting the speed, and for choosing whether the last point shown will be centred on the map window. The default speed is that in the track: the delay between the presentation of two consecutive points is the difference between their time stamps. If a time stamp is not defined the default delay is 30 seconds. The state of the animation and the total (real) time since the beginning (if defined) are displayed.

A track can be created from a route from the route window.

4.7 Groups

Groups are very useful in cataloguing the available data and in selecting information to be displayed on or cleared from the map, or to be transferred to/from the receiver or to/from a file. Groups are also used by GPSMan to present the results of a search as described below (4.8) and to perform some operations on sets of waypoints (defining an average waypoint (4.7), changing the position formats (4.7) or datums (4.7) and computing clusters of waypoints (4.7)).

A group contains a certain number of data items and is represented internally as set of item names (together with their types). Operations on a group may fail or succeed only partially if one of its elements is not currently in the data-base.

Groups can have other groups as elements but one group cannot be an element of itself even if indirectly (in technical terms: groups are well-founded sets).

Clearing from the map an item that belongs to a group that has been displayed will not affect the display-state of the group. To be sure that all the elements of a group are actually displayed, the user should clear the group from the map and then display it again.

Deleting from or adding items to a group will not affect their display-state.

Forgetting a group will delete permanently the group from the data-base but not its elements. This operation is not prevented by the fact that any of its elements cannot be cleared from the map.

Saving a group (to a GPSMan file) will save all the information on the group and on its elements.

Creating an average waypoint from the waypoints in a group can be made from the group window. The coordinates of the new waypoint will be the averages of the latitudes, longitudes and altitudes of waypoints in the group and its sub-groups (recursively).

Converting the position formats of the waypoints in a group can also be made from the group window. All the waypoints in the group and its sub-groups (recursively) will change to the (same) selected position format. If one of the waypoints is being edited, the position format in the edit window will also be changed and the position will revert to its initial value (when the edit window was created).

Converting the datums of the waypoints in a group can also be made from the group window. All the waypoints in the group and its sub-groups (recursively) will change to the (same) selected datum. This conversion will not be done for those waypoints whose position format is a grid requiring a fixed datum different from the selected one. If one of the waypoints is being edited, the datum in the edit window will also be changed and the position will revert to its initial value (when the edit window was created).

Clusters of waypoints can be created from a group by taking the waypoints in it (and its sub-groups, recursively) as centres of the clusters and searching the data-base for waypoints that fulfil a selected condition for each centre. The conditions that can be tested are: that the waypoint is within a given distance range of the centre, or that the waypoint belongs to the quadrangle of given latitude and longitude ranges whose middle-point is the centre. It is obvious that the first condition will be much slower to evaluate than the second, and therefore making clusters based on quadrangles should be preferred when the number of waypoints currently defined is large. Each cluster will be created as a group: its name is of the form `Cluster` n, and its remark has the name of the centre and either the quadrangle dimensions, or the distance range.

Input/output operations on the elements of a group allow for selecting which items of which types to read or write. In general the user will choose the groups and the item types for the operation. Then GPSMan collects in a list the names of the items of the given types that belong to the selected groups. This list of names is used to perform the I/O operation.

Selecting the "Group" type means that the search for items will be done in the groups that are elements of the selected groups, recursively. In more technical terms, the resulting list may be seen as a flattening of the group structure. In no case the list of names will contain names of groups.

Details of each specific operation are as follows:

- in output operations, the "All" menu entry means that all groups will be considered. When saving or putting elements this also means that all types should be considered.
- in input operations, there is the option of reading either the items whose names are not in the list of names GPSMan builds, or the items having the names in that list. The former is useful for preserving data in the selected groups; items that are not in the data-base will also be read in. The latter is useful for updating or restoring the information in the selected groups without affecting the other data; items that are not in the data-base will not be read in.
- when exporting or importing information to/in GPStrans format, a single type (apart from "Group") must be chosen because of the structure of GPStrans files.
- when getting information from the receiver the "Track" type cannot be used as there is no point in updating or changing previously recorded tracks.

4.8 Searching data items

In order to search data items the user specifies a set of constraints. An item will be included in the search results only if it verifies all the constraints in the set that are applicable to its type.

The types of items to be searched for can be more than one, to each type being applied only the constraints that make sense with it.

The search domain is either the entire data-base, or a set of groups. In the latter case, the search will be recursive, i.e., will also explore the groups that are elements of the given groups, and so on. Furthermore, if the search includes the type "Group", the given groups will be included in the search results.

The patterns for searching by names, comments and/or remarks follow the Tcl/Tk `glob` command conventions. In brief:

1. `?` stands for any single character
2. `*` stands for zero or more characters
3. `[`*xyz*`]` stands for any of the characters within the brackets
4. `[`*a*`-`*z*`]` stands for any character in the range *a* to *z*, inclusive
5. `\`*c* stands for the character *c*.

The distance to a waypoint or to a location given by its coordinates can be used to search for waypoints (a related operation is making clusters of waypoints (4.7)) and/or tracks. With tracks all track points of each track may have to be checked what may take a long time.

The search is based on either an allowable maximum distance, or a distance interval. A bearing for the search can also be given, together with an angle that will be centred along it.

Results , if any, are presented as elements of a new group with a name of the form `FOUND n` where `n` is a number. The remark of the group gives a succint description of the constraints used in the search.

A dialog window will be presented giving the choice between ending the search while keeping (`Ok` button) or forgetting (`Cancel`) the group with the results, and making a new search while keeping (`Another`) or forgetting (`Change`) the group.

4.9 Map

The map window will contain a graphical representation of data. It is assumed that the user has chosen the relevant datum and projection before asking for some data to be displayed.

Some information that may be relevant for choosing a datum is given when describing how to define new datums (4.11).

The available projections and the way new projections can be defined are described below (4.12). Projections may have parameters, in which case they are computed either when a data item is displayed and the map is void, or when a map background image is loaded. According to an option the user is asked to accept or change them.

When a map background image is loaded it will be geo-referenced and a transformation of coordinates may be selected for that purpose. There are three such transformations: affine, which covers rotation and non-conformality, affine conformal, and affine conformal with no rotation, that corresponds to applying only a scale factor and that is used when there is no background image. Obviously there will be deformation when either the projection or the transformation is not suitable for the image.

More detailed explanations of how to use background images and projections and coordinate grids are given in the next sections (4.10, 4.12).

Items can be displayed on the map by using the `Display on map` button in the map window. Other methods include:

- using the `Display on map` option when reading new data from files or the receiver,
- right-clicking on a name in an items list,
- using the `Display on map` option of the edit window for an item,
- using the display entry in the menu that pops up with `Control`-key left-click on a waypoint in the map.

To clear an item from the map there is the `Clear` menu-button in the map window. Other ways of achieving the same effect:

- right-clicking on a name in an items list,
- using the `Display on map` option of the edit window for an item,
- using the clear entry in the menu that pops up with `Control`-key left-click on a waypoint in the map.

A waypoint can be created on the map , if the map has been geo-referenced, by clicking with the mouse left-button on an empty place, or by using the `Return` (or `Enter`) key. This can only be done when no waypoint is being edited. When a route is being edited on the map the `Return` key has no effect, and the left-button on an empty place creates a waypoint that is added to the route (see below (4.9)). The position format for the new waypoint will be the one in use for the map cursor coordinates. UTM/UPS will be used instead when the position is out of the range of the selected grid. To finely position the cursor, the arrow keys for scrolling the map and the `Return` key should be used instead of the mouse.

A menu-button for a waypoint on the map will be created by pressing the `Control` key and clicking on the waypoint with the mouse left-button. It will allow for moving the waypoint (i.e., changing its position), starting the definition of a route (see next paragraph), or for displaying or clearing:

- all waypoints within a certain distance;
- all waypoints in the rectangle having as opposite corners this waypoint and a waypoint chosen from the menu;
- all routes containing this waypoint;
- all routes containing waypoints on the map.

A waypoint that is being moved is placed in its new position by using the mouse left-button. The right-button cancels the operation. A balloon will show the possible actions.

A route can be changed or created on the map by using

- the `Edit on map` button from the route edit window; there must be at least one waypoint in the route; or,
- the `Start RT` entry of the menu corresponding to a mapped waypoint when no route is being edited; the route edit window will be opened and the waypoint becomes the route starting point.

In either case, changes made on the route on the map will appear in the route window. The cursor will show the current insertion point that at first is the end point of the route, but that can be moved to in between any two waypoints of the route (if there are as many) — this may be seen as changing the corresponding route stage.

Edit operations are performed by using the mouse buttons and the `Shift` and `Control` keys, and/or by using a menu that will appear by pressing the `Control` key and clicking the mouse left-button (not on a waypoint!).

Clicking with the mouse

- left-button on a waypoint adds it to the route; a waypoint cannot follow itself in a route;
- left-button where there is no waypoint, creates a new waypoint and adds it to the route; if the operation is cancelled the waypoints created this way will be discarded;
- left-button together with the `Shift` key removes the previous waypoint from the route unless there is only one;
- right-button stops the route definition from the map; if there is a waypoint under the cursor it will be added to the route, otherwise a new waypoint is created and added to the route; the route defined so far can now be further edited in its window;
- right-button with the `Control` key changes the insertion point to the previous stage, if there is one;
- right-button with both the `Control` and the `Shift` keys change the insertion point to the next stage, if there is one, or, when changing the last stage, to the end of the route;
- middle-button (or left- and right-buttons) with the `Shift` key cancels the definition; the same can be achieved by using the `Cancel` button of the route edition window.

The operations available from the menu (`Control` key and the mouse left-button not on a waypoint) are the following (only those that are meaningful will be shown at any given moment; the corresponding shortcut using the mouse/keyboard is shown if there is any):

- stop editing on the map, and either include the current point under the cursor (right click), or do not add any more points;
- cancel the whole edit operation (`Shift` and middle click);
- delete either the previous waypoint (the one before the current insertion point; `Shift` and left click), or the first waypoint of the route;
- edit previous stage, i.e., change the insertion point to the previous stage (`Control` and right click);
- edit next stage, i.e., change the insertion point to the next stage, if there is one, otherwise to the end of the route (`Control` and right click);
- add to end, i.e., change the insertion point to the end of the route (when editing the last stage, this can be done with `Control` and right click);
- close menu, destroying the menu-button.

When using `Control`-right click and `Control`-`Shift`-right click to go from one stage to another the lines in the map are only redrawn when the cursor moves.

During the edition of the route, waypoints can be moved to other positions as described above (4.9).

Scrolling and panning the map can be done by using the `Locate` menu-button, the mouse, the keyboard, or a wheelmouse.

Selecting an item with the `Locate` menu-button (only items on the map are listed) scrolls the map so that the selected item becomes centred. In case of a route or track, this applies to its first point.

Dragging the mouse with the middle button down will pan the map.

The keyboard arrow keys and the `Space` and `Delete` keys scroll the map in the expected way, while the arrow keys with the `Shift` key scroll the map in the SE-NW and NE-SW directions.

Users of a wheelmouse can use the wheel in it for the same purpose: with no modifier key for vertical motion, with the `Shift` key for vertical motion by one page, with the `Alt` key for horizontal motion, and with the `Control` key for horizontal motion by one page.

As the cursor coordinates are updated when the cursor moves, the use of the keyboard for scrolling is also a means for finely positioning the cursor.

Reading items that are on the map will update the map, so that the items are shown according to their newly read definitions.

4.10 Map background images

A map background image can be loaded either from a file containing a GIF or PNM image, in which case it must be geo-referenced, or from an *image information file* (see 4.16.2 for its format) that contains geo-referencing information together with the path of the files containing images. GPSMan will automatically detect the kind of file it has to load from. It only makes sense to have as background images maps in one of the projections that GPSMan implements.

Geo-referencing a background image consists in selecting a projection and a coordinates transformation and in placing control waypoints in the image in order to fix the values of the parameters of the projection and the transformation. Only then is it possible to compute map coordinates from geodetic coordinates or the inverse. In fact, to convert from geodetic coordinates (i.e., coordinates in the spheroid, typically as latitude and longitude) into pixel coordinates in the screen there are two operations:

1. a projection, that from geodetic coordinates computes Cartesian plane coordinates, and
2. a coordinates transformation, that from Cartesian plane coordinates computes pixel coordinates.

This last operation is needed because the image can be rotated or distorted.

When geo-referencing an image to be loaded from a file in GIF or PNM format, the following information must be known:

- the projection used in the image,
- the datum,
- the coordinates transformation to use.

If the image is that of a map, the first two will hopefully be described in it. The corresponding options should be selected from the two menu-buttons at the left on the bottom of the map window, if the map window is the main window, or the `Datum` and `Projection` menu-buttons of the map window, if the lists window is the main window. As to the datum, it must be emphasised that some maps have a cartographic datum (the one used for projecting the map elements) and then one or more sets of grid lines projected using other different datums. The datum to be selected in GPSMan is the cartographic one, not any of the grid ones. On the other hand, if the intersection points of a grid are to be used as control points for geo-referencing the image, the datum for the grid should be used when creating the corresponding waypoints. More information on datums can be found below (4.11)

The transformations presently available in GPSman are

- affine conformal with no rotation. It is the one to choose if the central vertical line of the map image is oriented North-South (geographic, not magnetic) and there is no distortion in different directions (i.e., in each point the map scale is the same irrespective of the direction that is considered).
- affine conformal. To be used when the vertical of the image is not oriented N-S, and there is no distortion in different directions.
- affine. This is the more general case: the vertical of the image is not oriented N-S and there may be distortion in different directions.

Along with this information, 2 or 3 control waypoints with known coordinates will be needed. They will be placed over the image to geo-reference it. The first thing to do is to create these waypoints. It is a good idea to use either no symbol for them, or to use the `Mark, x` symbol so that later on they can be placed exactly where they should be in the image. If the transformation is the "affine conformal" one 2 waypoints will be needed, otherwise 3. In the latter case, the waypoints should be chosen so as to form an almost equilateral triangle, in order to minimise positioning errors.

After these preliminary steps, either the entry `Map->Background->Load` from the `Map` menu-button (if main window is the map window), or the entry `Load` of the `Background` menu-button (if main window is the lists window) should be selected. The file to be loaded is then chosen. This may be a GPSMan image information file (containing geo-referencing information) in which case the image is loaded with no further ado. If it is a GIF or PNM file, dialog windows will allow for the selection of the transformation to be used and the 2 or 3 waypoints that will serve as control points. The image is then presented in the map window. In the case of the "affine" and "affine conformal" transformations each of the selected waypoints are then placed over the image where the user thinks they should be. If the "affine conformal no rotation" transformation was selected, one of the waypoints is placed first and 2 lines will de drawn. Each of the other 2 waypoints must be over each of these lines. When the mouse is moved, the 2 wayponts will move over these lines until the user clicks the left-button to place them both at the same time.

The operation is finished by clicking on the `Ok` or `Cancel` buttons of the dialog window. The map scale cannot be changed if there is a background image, and an image can only be loaded to an empty map.

After geo-referencing an image, it can (should) be saved through the entry `Save geo-ref info` (under either `Map->Background`, or `Background` menu-buttons) so that the next time it can be loaded with no need for geo-referencing.

It is a fact that for the "affine conformal no rotation" transformation, 2 waypoints would be sufficient. However GPSMan asks for 3 to be placed so that the user may place 2 of them at the same time, in this way having more control on positioning errors. The 3 waypoints should form an almost equilateral triangle that can be shown in the map window. The order of the 3 waypoints is important, as the first one cannot be moved after being placed. This waypoint, then, should be such that there are no doubts on where it should go. It will be shown together with lines that will contain the other two, and will be placed by clicking the left-button. The other two will be placed as a pair in the same way, scale changes being displayed.

Other background images can be loaded after having one image geo-referenced by using the `Change` option of the map `Background` menu. All images are assumed to have the same size forming a grid, the same datum, projection and coordinates transformation being applied to all of them. This will be useful for loading different sheets of a map to the background.

4.11 Datums and ellipsoids

A horizontal (or geodetic) datum defines the form and the position relative to the Earth axis of the geometric reference surface of the Earth used for locating points and in projections. The form is an ellipsoid which is usually defined by giving its semi-major axis `a`, and its flattening `f` (or its inverse), i.e., the quotient of the difference between its semi-major and semi-minor axes by its semi-major axis. Its relative position is described by the shift in Cartesian coordinates (`dx`, `dy`, `dz`) with respect to a reference datum, usually the "WGS 84".

GPSMan contains comprehensive sets of datums and ellipsoids. Their definitions have a remark field used for documenting them whenever possible, as well as fields for the error estimate in meters (`ex`, `ey`, `ez`; the value `-1` stands for unknown), the number of satellite measurement stations, and the zone of validity given by S-N latitudes and W-E longitudes. All these fields are for information only and may be empty. The definitions can be inspected (but not changed) from the corresponding entries under the `Definitions` menu-button. It should be noted that some datums have variants for different regions. For instance, the "European Datum 1950" has at least 15 such variants and it has been observed that Garmin receivers do use the local variant for Portugal/Spain when this datum is selected and a waypoint in Portugal is created. This means that using the average "European Datum 1950" in such a situation may lead to large position errors. Probably the same will happen with other datums having variants.

Users may define their own datums and ellipsoids from the entries under the `Definitions` menu-button. These definitions, that cannot override those in GPSMan, are automatically saved in a file in the GPSMan user directory, and will be loaded when GPSMan is started. Currently GPSMan does not prevent changing or forgetting a datum or ellipsoid that is in use: it is the user's responsability to avoid inconsistencies due to such operations. When sharing files having data depending on user-defined datums with other users, the definitions of the relevant datums and ellipsoids should also be shared.

4.12 Projections and coordinate grids

4.12.1 Selecting and defining projections

Selecting the map projection is done by using the second (from the left) menu-buttons on the bottom of the map window if the map window is the main window, or the `Projection` menu-button if the lists window is the main window.

If a background image is to be loaded the projection and the datum should be set to the projection and datum used in the image (see above (4.10) for the details on this). If there is no image, the map projection should be selected according to the map scale and the geometry of the region to be covered.

Projections can be either pre-defined or user-defined. There are a small set of pre-defined projections. Some of them admit particular cases, in the sense that they have parameters whose values can be fixed. The user may define such particular cases along with a coordinates grid associated to it.

Each projection has an associated coordinates grid that will be used as default position format for displaying the map cursor coordinates and when a waypoint is created from the map. This position format can be changed from the map window (menu-button near the cursor coordinates).

When defining a projection, the user may also define a new coordinates grid User-defined grids cannot have more than one zone.

User-defined projections and grids are automatically saved in a file in the GPSMan user directory, and will be loaded when GPSMan is started.

To define/change a projection there are the appropriate entries under the `Definitions` menu-button.

When defining a new projection, which is necessarily a particular case of a general projection, the user must select first the general projection to use, along with a name and short name. The short name is for internal use and will also serve as the coordinates grid name, if the user associates one to the new projection. The values of the projection parameters must be then given. The user may either associate to the new projection an existing grid, or create a new grid by selecting a distance unit (currently either metres or feet), by giving the values for the false easting and northing (for some projections these parameters are in fact the easting/northing of the false origin or of the projection centre), sensible bounds to the coordinates, and by choosing whether or not a fixed datum must be used with the grid. The bounds given will be used to check that the grid is not used outside its intended scope. All values of latitudes and longitudes must be given either in the datum of the grid if there is a fixed one, or in the datum being used for the map.

An user-defined grid cannot be forgot if it is currently associated to another projection or in use for displaying the map coordinates. Changing the definition of a user-defined grid may cause inconsistencies in previously projected data.

4.12.2 Pre-defined projections and grids

With the UTM/UPS (Universal Transverse Mercator/Universal Polar Stereographic) projection a single UTM zone is used, that of the first point displayed. Points in different zones will be projected into the same zone what may produce some deformation. There are no parameters that can be changed by the user.

The Transverse Mercator projection, also known as Gauss or Gauss-Kruegger projection, has 3 parameters: the latitude and longitude of the centre and the scale factor at the central meridian. The first two are computed as the averages of the latitudes/longitudes of the first points being mapped, while the third one has the default value of 0.9996 (used for UTM).

Particular cases of the Transverse Mercator projection are used in several maps. GPSMan pre-defines the following ones:

- the Portuguese Military Maps projection, used in maps published by the Portuguese Army Geographic Institute. Parameters: central latitude `39.66666666666667`, central longitude `-8.131906111111111`, scale factor `1`. The datum to be used is called “Lisboa”. Military coordinates in these maps correspond to a false easting of 200km and a false northing of 300km.
- the German Grid projection (GKK: Gauss-Krueger-Koordinatensystem). Parameters: central latitude `0`, central longitude in zones of 6 degrees centred at `0`, `3`, `6`, `9`, `12`, and `15E`, scale factor `1`. Coordinates in the GKK grid have a false easting of $z \times 1000 + 500$ km, where z is the zone number.
- the British National Grid (BNG) projection. Parameters: central latitude `49`, central longitude `-2`, scale factor `0.9996012717`. The datum to be used is called “Ordnance Survey Great Britain”. Coordinates in this grid correspond to a false easting of 400km and a false northing of 100km.
- the British West Indies projection. Parameters: central latitude `0`, central longitude `-62`, scale factor `0.9995`. The datum to be used should be based on the “Clarke 1880” ellipsoid. Coordinates in this grid correspond to a false easting of 400km.
- the Irish Transverse Mercator Grid (ITM) projection. Parameters: central latitude `53.5`, central longitude `-8`, scale factor `1.000035`. The datum to be used is called “Ireland 1965”. Coordinates in this grid correspond to a false easting of 200km and a false northing of 250km.
- the Uniform Finnish Grid (KKJY) projection. Parameters: central latitude `0`, central longitude `27`, scale factor `1`. Coordinates in this grid correspond to a false northing of 500km. There is a single zone named `27E`.
- the Basic Finnish Grid (KKJP) projection. Parameters: central latitude `0`, central longitude in zones of 6 degrees centred at `21`, `24`, `27`, and `30E`, scale factor `1`. Coordinates in the KKJP grid have a false easting of $z \times 1000 + 500$ km, where z is the zone number.

- the Swedish Grid (SEG) projection. Parameters: central latitude `0`, central longitude `15.808277777778`, scale factor `1`. Coordinates in this grid correspond to a false easting of 1500km.
- the Taiwan Grid projection (TWG). Parameters: central latitude `0`, central longitude in 6 zones of 2 degrees centred at `115`, `117`, ..., `125`, and scale factor `0.9999`. Coordinates in the TWG grid have a false easting of 250km. This grid is usually employed with either the Hu-Tzu-Shan datum (also known as TWD67), or the TWD97 datum (whose definition could not be found for inclusion in GPSMan).

The Lambert Conic Conformal projection has two variants: single standard parallel (named `Lambert Conic Conf 1` in GPSMan), and two standard parallels (named `Lambert Conic Conf 2` in GPSMan).

The former has 3 parameters: the latitude and longitude of the centre and the scale factor at the natural origin. The first two are computed as the averages of the latitudes/longitudes of the first points being mapped, while the third one has the default value of 1 (corresponding to a tangent cone; a value of less than 1 stands for a secant cone).

The latter has 4 parameters: latitudes of the two standard parallels (along which the cone intersects the geoid) and of the false origin, and longitude of the false origin. The first two default to the extremes of latitudes of the first points being mapped, and the position of the false origin defaults to the average of the positions of these points.

The Mercator projection can be defined as a Lambert Conic Conformal projection either with the equator as its single standard parallel, or with the two standard parallels at equal North and South latitudes (i.e., symmetrical with respect to the equator).

This leads to two variants: single standard parallel (named in GPSMan `Mercator 1`), and two standard parallels (named in GPSMan `Mercator 2`).

The former has 2 parameters: the longitude of the centre and the scale factor at the natural origin. They are taken as the average of the longitudes of the first points being mapped, and as 1, respectively.

The latter has 3 parameters: the latitudes of one of the two standard parallels and of the false origin, and longitude of the false origin. The first default to the maximum of the absolute values of the latitudes of the first points being mapped, the position of the false origin defaults to the average of the positions of these points.

The Stereographic projection is an azimuthal conformal projection used both for large scale and small scale mapping. There are 3 possible aspects: polar, oblique and equatorial, which are dealt with automatically by GPSMan. A particular case of this projection is the Universal Polar Stereographic (4.12.2) that is used in the UTM/UPS.

The Stereographic projection has three parameters: the latitude and the longitude of the centre (tangent point) and a scale factor. By default the scale factor is 1 and the coordinates of the centre are taken as the average of the latitudes of the first points to be mapped.

The Cassini-Soldner projection is a neither conformal nor equal-area projection used in the 19th century. It is still used for mapping areas with a small E-W extent. Scale is true along a central meridian and distortion increases significantly with distance from it. It has two parameters: the latitude and the longitude of the natural origin. These parameters are taken as the averages of the latitudes and longitudes of the first points being mapped.

The American Polyconic projection is also a neither conformal nor equal-area projection used before the computer era. It has a single parameter: the standard latitude, whose default value is taken as the average of the latitudes of the first points to be mapped.

4.12.3 Some national grids

The following information gives the parameters needed for defining some national grids. The coordinates given as parameters depend on the datum used in the definition; if there is none, GPSMan uses the datum currently selected for the map. This means that the coordinates given below must be converted if a different datum is used.

The Iceland grid is based on the Lambert Conic Conformal projection with 2 standard parallels at N64.75 and N64.25 degrees, a false origin at N65, W19 degrees, using distances in metres, a false easting and a false northing of 500km, and the "Hjorsey 1955" datum.

The Netherlands grid uses the Stereographic projection, centred at N52.15616, E5.38763333333 degrees (this corresponds to the Amersfoot OLV church, N52.15517, E5.38720 in the "WGS 84" datum), a scale factor of 0.99991, distances in metres, a false easting of 155km and a false northing of 463km, and the "Rijks Driehoeksmeting" datum. Acceptable ranges of values are: 0–290000 for x, 290000–630000 for y, 50.3–53.45 for latitude, and 3–7.45 for longitude.

4.13 Distances and bearings

There are two sets of formulae for computing distances and bearings that the user may choose

1. the so-called Law of Cosines for Spherical Trigonometry, that is not very accurate but is quite fast, and
2. the modified Rainsford's Method with Helmert's elliptical terms with a high degree of accuracy but slower; this method cannot be applied if one of the points is a geographical pole, in which case GPSMan applies the Law of Cosines.

Experiments with them seem to indicate that the differences to be expected are in the range of less than 100 metres in distances of more than 10 kms, and no differences in bearings when they are presented in degrees as integers.

Bearings in GPSMan are always geographic (True North).

4.14 Real-time logging

At present there are two variants of the implementation, that will probably be merged in the future. Any receiver sending data in the NMEA 0183 v2.0 standard format can be used with GPSMan and can use any of the two variants. This also applies to Garmin and Lowrance receivers.

Users of Lowrance receivers will want to use the variant for Lowrance. Users of Garmin-defined protocols, either the so-called Garmin protocol , or the Simple Text Output Protocol, should use the variant for Garmin.

Both variants implement some sort of simulator that can be helpful for tests and in getting acquainted with the interface before going to real-time usage.

GPSMan will work with the variant corresponding to the receiver brand selected in the options menu. After changing this option the program must be restarted because different code has to be loaded.

4.14.1 Variant for the Lowrance

This variant was designed and implemented by Brian Baulch (baulchb@hotkey.net.au) who has prepared a description of it that can be found in Appendix B.

The file `exerciser.tcl` used for simulation by this variant can be found in the `util` directory. It must be edited for configuration before use.

4.14.2 Variant for the Garmin

This variant supports the following protocols:

- Garmin PVT (position, velocity and time) Data Protocol, which is a part of the Garmin (`GRMN/GRMN` or `Garmin`) protocol,
- Garmin Simple Text Output Protocol (`Text Out`), and
- part of NMEA 0183 v2.0.

The receiver must be configured to use one of these protocols. On Garmin receivers this is done in the receiver's `Interface` display under `Setup`. Not all Garmin receivers support the first two, in which case NMEA 0183 should be selected and the variant for the Lowrance may also be used. If the selected protocol is not supported, either GPSMan knows about that and issues a warning, or there will be no information captured by GPSMan.

Facts that may help in choosing among the available protocols:

- Garmin PVT can be used along the rest of the Garmin protocol, meaning that getting and putting other information from/into the receiver can be done while real time logging is on; the receiver will temporarily stop sending logging information while these operation take place — this may be DANGEROUS if the logging information is crucially needed for navigation; it is the user's responsability not to initiate such operations in these conditions;
- both Simple Text and the implemented part of NMEA 0183 are one way protocols: information is only sent from the receiver to GPSMan; this means that it is not possible for GPSMan to check the connection with the receiver: GPSMan will be passively waiting for information to appear on the serial port;
- Simple Text carries less information than Garmin PVT (neither EPE, expected position error, nor EPV, expected position vertical error), while NMEA 0183 may carry more information than Garmin PVT; it is difficult to say more than this because there is no complete information on which NMEA sentences (commands) are sent by receivers.

Selecting the protocol in GPSMan is done in the GPSMan's receiver window using the `Protocol` menu, or the entry with this name of the `GPS Receiver` menu. The `simulator` entry will launch a random generator of (somewhat inconsistent) logging data that will be helpful in getting acquainted with the interface before real-time usage.

Controlling the real-time logging is done with the three buttons `Get Log/Stop`, `Record` and `Animation` in the receiver window, or the entries of the `GPS Receiver->Real-time track log` menu. The first starts and stops the input of logging information, the second launches a window that records that information, and the third starts the animation on the map. These buttons/entries can be actuated independently of each other, but it is obvious that the recording or the animation cannot start or go on if the input has not started or has been stopped. In this way the user may select when to record or when to have the animation.

The control buttons in the recording window and in the animation control window affect only the recording and the animation, respectively, except in what concerns the logging time interval which is the same for the recording and the animation. The minimum value for the time interval depends on the rate at which the receiver sends information. The initial value for it is 2 seconds. The recording window and the animation control window will appear only after the first valid logging information is received, and this means at least 2 seconds from the clicking on the buttons/entries.

The recording window shows several columns with the logging information. These are, from left to right:

- number of the fix,
- local date and time,
- the latitude and the longitude (datum: "WGS 84"),
- altitude in metres,
- quality of the position fix,
- EPE (estimated position error), EPH (expected position horizontal error), EPV (expected position vertical error) in metres,
- the 3 coordinates of the velocity vector in metres/second,
- the current bearing (CMG, course made good, track made good), true North.

Columns for which there is no information for the very first fix will be hidden automatically. The title of a column is a button that hides the column. This will be wanted for columns that are not being used or needed. The information in a hidden column is not lost and is updated. At any time a hidden column can be shown again by selecting its name from the `Show` menu.

The `Restart` button will destroy all the recorded information and restart recording. The `Save` button saves as text the contents of the columns. This text cannot be re-loaded by GPSMan. To save the information in a format readable by GPSMan the `Make TR` button should be clicked to create a track, which can then be saved and loaded in the normal way.

The moving map works as the animation for a track described above (4.6). The main difference is in the scale that instead of setting the animation speed sets the logging interval.

For the time being there is no automatic loading of background images, a feature present in the variant for the Lowrance.

4.15 Miscellaneous

- changes in option values in some cases do not take effect immediately but only after GPSMan is restarted. Some care should be taken to avoid inconsistencies due to this. In particular, changes in the distance unit affect the possible values for the initial map scale, so that a change in the latter is normally needed in the next session after changing the former.
- anything that looks like a button normally *is* a button.
- closing a window from the window manager may cause data to be lost, and GPSMan may be unable to create it again.
- at any time only one waypoint, one route, one track and one group may be open for editing; other such items may be viewed but not edited.
- when exiting from the program (`GPS Manager` button, or `ctrl-c` in the GPSMan windows), unsaved data will be lost unless the interface state is to be saved (see above (4.3)). As saved state files will be overwritten automatically by GPSMan it is a good idea to save important data to a file before quitting the program.
- in an input operation asking for the data read in to be displayed on the map may turn out to be a time consuming task.

4.16 Files

GPSMan uses text files to store data. The `Load/Save` options in the menus deal with files in GPSMan format. The `Import/Export` options deal with files in foreign formats. In the GPStrans format (described in the documentation of GPStrans), all positions are exported in DDD format, although any available position format is accepted in imported files.

Files in GPSMan format can be either item information files (with data of different types: waypoints, routes, tracks and/or groups), or image information files (for saving information on background images for the map).

These file formats are independent of the language used. That is, there will not be commands in Tobagonian even if a `lang*.tcl` file was provided for it and GPSMan was set to use that language.

4.16.1 Item information files

Item information files in GPSMan format (based on the GPStrans format) are as follows:

- lines whose first character is a `!` character are commands:

  Format definition commands used to describe the format used thereafter; before the definition of waypoints, routes or tracks a position format and a datum must be given.

  - `!Format: P T D`, where `P` is the position format (one of `DMS`, `DMM`, `DDD`, `UTM/UPS`), `T` is time offset relative to UTC (a floating-point number between -12 and 12), and `D` is the datum name (to end of line).
  - `!Position: P`, where `P` is the position format (one of `DMS`, `DMM`, `DDD`, `UTM/UPS` or a coordinates grid name).
  - `!Datum: D`, where `D` is the datum name (to end of line).
  - `!Creation: B`, where `B` (one of `yes` or `no`) states whether creation date fields are used.

  Data commands used to start a data section:

  - `!W:`, next lines (up to another data command or end of file) describe waypoints.
  - `!R: N C`, definition of route number `N`, with comment `C` (up to end of line). After such a line there may appear a remark (see `!NB:` command below). Next lines (up to another data command or end of file) describe the route waypoints and the route stages if any.
  - `!T: M`, definition of track named `M`. After the name and a tabulation character, fields (separated by tabulations) may occur that have attribute-value pairs under the form `Attr=Val` describing hidden information. After such a line there may appear a remark (see `!NB:` command below). Next lines (up to another data command, format definition command or end of file) describe the track points.
  - `!G: M`, definition of a group named `M`. After such a line there may appear a remark (see `!NB:` command below). Next lines (up to another data command, format definition command or end of file) describe the group elements.
  - `!NB: T`, text remark `T` for waypoint, route, track or group; must appear after a `!R:` or `!T:` command, or after a line describing a waypoint. The text is terminated by a blank line.

  Ancillary commands used

  - to describe route stages: `!RS:`; and
  - to define the type of group elements (see below): `!GW:`, `!GR:`, `!GT:`, and `!GG:`.

- lines describing waypoints (a `!W:` or `!R:` command appeared before) have a name, a comment, a creation date (but see the `!Creation:` command) and a position; all these fields are separated by tabulation characters. After these fields, in the same line and also separated by tabulations, there may be pairs under the form `Attr=Val`, where `Attr` is an attribute and `Val` the corresponding value; attributes currently in use, apart from those for hidden information: `alt` for altitude in metres, `symbol` (possible values: GPSMan symbol names, see file `symbols.tcl`), and `dispopt` (possible values: GPSMan display option names, see file `symbols.tcl`). After such a line there may appear a remark (see `!NB:` command above). A route waypoint may be given solely by its name if it has been defined before in the file.
- lines describing route stages (only one between two consecutive route waypoints) start by `!RS:` followed by a tabulation, a field with the comment, a tabulation, and a field with the label. Attribute-value pairs for hidden information may appear after a new tabulation and separated by tabulations. Empty stages should not appear.
- lines describing points in a track (a `!T:` command appeared before) have a tabulation character followed by a date, the position, the altitude in meters, and the depth in meters, all fields being separated by tabulation characters. If the altitude and the depth are undefined both fields are omitted; if only the depth is undefined its field is omitted; otherwise the altitude field must be present and should be void if the altitude is undefined. GPSMan accepts track point positions in any available format, but will convert them to DMS.
- lines describing elements of a group (a `!G:` command appeared before) have a first field followed by a tabulation character followed by a name (up to end of line). The first field is either empty or of the form `!GW:`, `!GR:`, `!GT:`, or `!GG:` that stand for group waypoint, route, track and group, respectively, and describes the type of the element. If this field is empty the type is the same as that of the previous element. A group is assumed to be well-founded: it cannot be an element of itself even in an indirect way.
- positions given by latitude/longitude are given as two fields (each as a DMS, DMM, or DDD coordinate); positions in UTM/UPS have four fields: East zone number, North zone letter, x- and y-coordinates; positions in other coordinates grids have three fields: zone (possibly empty), easting and northing. All fields are separated by a tabulation character.
- blank lines are ignored, except as terminators of remarks (see `!NB:` command above).
- file comments (ignored by GPSMan) start by a `%` character that can be preceded only by spaces and extend to the end of line.
- attribute-value pairs that describe hidden information are written as follows:
  - the attribute name starts with a capital letter that uniquely identifies the brand of the receiver (`G` for Garmin, `L` for Lowrance); the rest of the name depends on the implementation but normally will describe the protocol and the data field;
  - the value is a string containing standard ASCII characters excluding all control characters (i.e., all codes must be ≥ 32 and < 127); the codification of the value is also implementation dependent (for an example, see the comments in `proc HiddenCode` in file `garmin.tcl`).

4.16.2 Image information files

These are files containing the following information:

1. a `!Image: P` command, with `P` the absolute path of the file containing the image in GIF or PNM format;

2. a `!Datum: D` command, with `D` the datum name for the coordinates;
3. a `!Projection: NP As` command, with `NP` the name of the projection to use and `As` a sequence of attribute-value pairs under the form `Atr=Val` describing projection parameters; the tabulation is used as separator for `NP` and each pair;
4. a `!Transf: NT As` command, with `NT` the name of the coordinate transformation to use and `As` a sequence of attribute-value pairs as in the previous command;
5. a `!Scale: S` command, where `S` is the floating-point value of the map scale in pixel/metre.

After this there may be one or more lines with a `!Image at: XG,YG P` command, where `P` is the absolute path of the file containing the image in GIF or PNM format, and `XG,YG` are the grid coordinates of the image. The grid coordinates of the first-loaded image are `0,0`. `GX` changes by 1 (-1) for each image to the right (left), and `GY` changes by 1 (-1) for each image down (up).

No newlines are allowed within these commands, and arguments are separated by spaces or tabulation characters unless otherwise stated. Paths must use the slash (`/`) as separator.

4.16.3 Map information files

These are files currently used only for saving the state of the map when there is no background image. They follow the same conventions as the image information files and contain the following commands:

1. a `!Map:` command;
2. a `!Datum: D` command, with `D` the datum name for the coordinates;
3. a `!Projection: NP As` command, with `NP` the name of the projection to use and `As` a sequence of attribute-value pairs under the form `Atr=Val` describing projection parameters; the tabulation is used as separator for `NP` and each pair;
4. a `!Transf: NT As` command, with `NT` the name of the coordinate transformation to use and `As` a sequence of attribute-value pairs as in the previous command;
5. `!Position: P`, where `P` is the position format (one of `DMS`, `DMM`, `DDD`, `UTM/UPS` or a coordinates grid name).
6. a `!Scale: S` command, where `S` is the floating-point value of the map scale in pixel/metre.

4.17 GPSMan Symbols

GPSMan defines a set of symbols for waypoints that is described below under four categories (not mutually exclusive): general use, land, water, and aviation. This set is based on the symbols described in the "Garmin GPS Interface Specification" (Revision 3), but extends it, including, for instance, the symbols used by Lowrance receivers (contributed by Brian Baulch). The GIF files for these symbols provided in the distribution were produced expressly for use with GPSMan, with some by Brian Baulch. It is recognized that both these images and the set of symbols can be improved and any help will be appreciated.

4.17.1 Category: General use

WP			
Danger	Skull	Bell	
Flag	Trace-back	Dollar	
(transparent)	(void)		
Ball	Dot	Mark, x	Circled X
Diamond, green	Diamond, red		
Square, green	Square, red		

4.17.2 Category: Land

First aid	Info		
City, small	City, medium	City, large	City, star
Car	Rent-a-car	Car repair	Tow truck
WC	House	Building	
Pharmacy	Phone	Post-office	Police
Tunnel	Bridge	Dam	Levee
Mountains	Elevation	Summit	
Ladder	Trail head	Tracks	Many tracks
Deer	Duck	Fish	Fish bank
Tree	Parking	Lodging	Park
Castle	Monument	Church	Chapel
Cemetery	Museum	Theater	Casino
Zoo	Scenic	Airport	Mine
Oil field			
Food	Fast food	Mug	Pizza
Movie	School	Shopping	Store
Stadium	Amusement park	Beach	Swimming
Showers	Skiing	Golf	Bowling
Snow skiing	Ice skating		
Fitness	Picnic	Camp site	Drinking water
Recreational Vehicle park			
Fuel	Fuel & store	Horn	
Exit	Exit, no services	Exit no serv large	
Mile marker	Border	Toll	
Freeway	National highway	Highway	State highway
US highway			
Street intersection	Ramp intersection	Ramp int. large	
Truck stop	Weight station		
Parachute	Glider	Ultralight	
Tower, tall	Tower, short	Take-off	Landing
Geo name, land	Geo name, man-made	Geo name, water	
Civil location	Military location		

4.17.3 Category: Water

Anchor	Fuel		
Boat	Boat ramp	Fish	Fish bank
Light	Man over board	Beach	Swimming
Wreck	Dam	Mile marker	Radio beacon
Buoy, white	Buoy, amber	Buoy, black	Buoy, blue
Buoy, green	Buoy, green red	Buoy, green white	Buoy, orange
Buoy, red	Buoy, red green	Buoy, red white	Buoy, violet
Buoy, white	Buoy, white green	Buoy, white red	
Diver down 1	Diver down 2		

4.17.4 Category: Aviation

Airport	Heliport	Private field	
Seaplane base	Soft field	Landing	Take-off
Radio beacon	Danger (avn)		
1st approach fix	Localizer outer marker		
Missed approach point	ND beacon		
TACAN	VHF omni-range	VOR-DME	VOR/TACAN
Controlled Area	Restricted Area	Intersection	
Parachute	Glider	Ultralight	
Tower, tall	Tower, short		

Chapter 5

Support for Lowrance and Garmin Receivers

5.1 Support for Lowrance receivers

Support for Lowrance receivers was developed by Brian Baulch (baulchb@hotkey.net.au) who has written a draft supplement for the present document that can be found on Appendix A.

5.2 Support for Garmin receivers

Any Garmin receiver should (theoretically) connect with no problems to GPSMan. It must be set to use the Garmin protocol: in the receiver's `Interface` display, under `Setup`, the `Garmin/Garmin` or `Garmin` option must be selected. Alternatively, for real-time logging only, it can be set to use the NMEA 0183 protocol, by selecting the `NMEA` option. For the use of this protocol see the description of real-time support (4.14).

When using the Garmin protocol GPSMan may need to convert between bytes and floating point numbers. Tcl/Tk has no machine-independent way to do these conversions and GPSMan only implements them for little- or big-endian architectures that follow the IEEE floating point standard (this will cover most personal computers and workstations). Some Garmin receivers do not use protocols having floating point numbers and are not affected by this. In any case when connecting to the receiver GPSMan tests whether there are problems with the conversions, in which case the user is asked to confirm or cancel the operation.

GPSMan follows closely the "Garmin GPS Interface Specification", December 6 1999, 001-00063-00 Revision 3, available from the Garmin WWW site. This document is known to be already outdated and probably not completely correct, as tests with recent models show.

Some data fields are not directly accessible to the user but are nevertheless kept by GPSMan as hidden information as described above. This is the case with the data on proximity distance, facility name, city, state, country code, and class.

GPSMan identifies the receiver model when it first connects to it. If the receiver implements the Protocol Capabilities protocol the list of protocols it uses is also obtained. This will probably be the case with the more recent models. Otherwise a table for the protocols to use is looked up. At present there are entries in it for the receiver models in the list below.

A problem was detected with a Garmin GPS 12Map that sends some packets twice. This caused havoc in the count of packets and made GPSMan to reset the connection. The solution has been to implement a test for repeated packets that are discarded if a flag is set.

eMap	eTrex	eTrex Euro	eTrex Legend
eTrex Mariner	eTrex Summit	eTrex Venture	eTrex Vista
GPSMAP 295	GPS III Plus	GPS 12Map	
GPS 12CX	GPS 12	GPS 12 (<3.01)	GPS 12 XL
GPS 12 XL Chinese	GPS 12 XL Japanese		
GPS 120	GPS 120 Chinese	GPS 120 XL	GPS 125 Sounder
GPS 126	GPS 128	GPS 38	GPS 38 Chinese
GPS 38 Japanese	GPS 40	GPS 40 Chinese	GPS 40 Japanese
GPS 45	GPS 45 Chinese	GPS 45 XL	GPS 48
GPS 55	GPS 55 AVD	GPS 65	GPS 75
GPS 89	GPS 90	GPS 95	GPS 95 AVD
GPS 95 XL	GPS II	GPS II Plus	GPS III
GPS III Pilot	GPSCOM 170	GPSCOM 190	GPSMAP 130
GPSMAP 130 Chinese	GPSMAP 135 Sounder	GPSMAP 175	GPSMAP 180
GPSMAP 195	GPSMAP 205	GPSMAP 210	GPSMAP 220
GPSMAP 230	GPSMAP 230 Chinese	GPSMAP 235 Sounder	

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Appendix A

Lowrance supplement to the GPSMan Documentation

```
Lowrance supplement to the GPSMan Documentation.
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1)  GPS receiver setup.

Follow the instructions given in your Lowrance manual. Set the
Com Port to 19200 bps, 8 data bits and no parity. Use the
correct Lowrance accessory data cable for your particular unit.

2)  Getting Waypoints from the GPS unit.

The Lowrance GlobalNav 212 receiver stores up to 999 Waypoints
internally. GPSMan downloads all 999 whether valid or not. The
indices of invalid (Unallocated) Waypoints are listed by
GPSMan and unused index numbers allocated when new Routes are
made or new Waypoints are created by GPSMan. For this reason all
Waypoints and Routes are read into buffers on initialisation of
the serial interface. This read operation can take nearly two
minutes at 19200 baud, please be patient.

The buffer mentioned above is not read into GPSMan memory until
the "Get WPoint" and "Get Route" buttons in the GPSMan "GPS
Receiver" window are clicked. This should be done before creating
any Waypoints or Routes with GPSMan, all Waypoints and/or Routes
should then be saved to the receiver before exiting GPSMan.

3)  Waypoint Names.

GPSMan is now able to handle Waypoint names containing spaces, so
spaces are no longer automatically deleted.

Note that the ASCII characters ".", "’", "(", "/", ")" and "-" can
also occur in Lowrance along with the ASCII space character (" ").

4)  Lowrance Trails.
```

The terms "trail" and "track" are used interchangeably by GPSMan.

5) Time Offset.

GPSMan for Lowrance does not use the "Time Offset" setting under
the options menu. However it is recommended that this variable
be correctly set, for compatibility reasons. All times are displayed
in local time, not UTC.

This program uses the Lowrance LSI 100 interface protocol rev 1.1.
Copies of this protocol are available from www.lowrance.com.

Feedback welcomed.

Appendix B

Support for real-time logging (variant for the Lowrance)

```
*** This file has changed - Feb 2002. ***

***************************
Welcome to GPSMan-autoMapic.
***************************

GPSMan-autoMapic is beta software designed to give moving-map real-time
plotting. It is not receiver-specific, and should work with any GPS receiver
that has the ability to output a standard NMEA 0183 v2.0 "GGA" sentence.
It has been developed on a ThinkPad 380 (150Mhz Pentium) using a Lowrance
GlobalNav 212 receiver, and tested with both the Auslig RASTER250K map series
(150 dpi, original margins cropped by the author) and with a4 scans (120
dpi) of city street-maps.

*** Warning ***
The performance of this software is dependent on computer speed!
GPS Receivers that output a string of NMEA sentences, without the
ability to turn off those not required, may cause buffer-overflow when using
slower computers. This is a Tcl feature and beyond my control at the
moment. This bug may limit the size of map images that can be loaded.
For example, an a4 image appears to be the limit with all sentences turned
on in the Lowrance receiver & using a ThinkPad 380. A more powerful machine
will handle larger images, test with "exerciser", details are given below.
Feedback to baulchb@onthenet.com.au will help us in deciding on future
development.

Use of the software is straightforward. The Map images required should have
been prepared and georeferenced in the normal GPSMan fashion. Then an ".aut"
file has to be prepared to show the bounding box for each georeferenced
sheet needed. This file has to be manually prepared and has five or six
tab-separated fields in each record, one record per line. The fields required
are -

Image-file path. (The path of the .img file created during georeferencing)
Latitude of the bottom of the image quadrangle, signed DDD format.
```

Latitide of the top of the image quad, likewise.
Longitude of the left side.
Longitude of the right side.
Optional image name or number. Can include any ASCII character including space.

There is no header required or permitted.

An simple example file (example.aut) -

```
~/Images/se5401.img     -17     -16     138     139.5   CHARTERS TOWERS
~/Images/se5402.img     -17     -16     139.5   141     MOUNT ISA
```

The images must be specified in degrees. If working with UTM or national grids, convert the co-ordinates to DDD positions with GPSMan.

Adjacent images can overlap, in fact this is preferable. If a point falls into a space between adjacent images a warning will be posted by GPSMan, the same warning will be posted if no .aut file is loaded or the position "falls off the edge of the world". As soon as the position falls within an image's bounds again then that image will be loaded.

The plotting function is started from the "Receiver" window of GPSMan. A window will appear from which the logging interval can be set and the *.aut file loaded. The plotting interval cannot be changed, all points received will be plotted. To stop plotting/logging click the "Stop" button at the top of the screen.

If NMEA logging is all that is required, use the "Preload image" button to start the software. A map image can be preloaded but need not be. This is the best way of using slow machines.

The "exerciser.tcl" test sentence generator.
****

(Note - some Lowrance/Eagle models include a "Simulator" which is preferable to the "exerciser". Follow the instructions in the Lowrance manual.)

This program can be used for stationary testing of the autoMapic function. It requires the use of another computer and a null-modem cable or adaptor (e.g. a breakout box). Exerciser.tcl will send a series of NMEA sentences at preset intervals. Initial settings are controlled by the "set" statements at the top of the program, change with a text editor. An explanation is given below, but make the changes in the program, not here.

```
set SRLPORT /dev/ttyS0  # set serial port correctly.

set BaudRate 4800       # NMEA Standard.

set Hours "0"           # Do not change
set Minutes "0"         # ditto
set Seconds "0"         # ditto
```

```
# Set Interval to 1000 (1 sec.) for Lowrance (2000 for Garmin?)
set Interval 1000

# Latitude of the desired starting point.
set LatDeg 27
set LatMin 54.30
set LatSign S           # N or S as applicable.

# Longitude of the desired starting point.
set LongDeg 153
set LongMin 19.334
set LongSign E          # E or W as applicable.

# Size and direction of steps. The units are minutes.
set LatIncr 0.03
set LongIncr -0.05

# Change to 1 (true) to send the entire (Lowrance) series of sentences.
# 0 (false) sends only the required GGA sentence.
set SendDummies 0

To use the exerciser, first copy exerciser.tcl to the "dummy" computer which
must have Tcl/tk loaded. Start exerciser.tcl then start GPSMan on the
"Primary" computer. The two computers should have had serial ports already
connected with the null-modem cable.

Brian Baulch (baulchb@hotkey.net.au) 2 Feb 2002.
copyright (c) Brian Baulch 2000, 2002.
```

Appendix C

Recent Changes

The following is a summary list of the more important changes made recently, no mention being made of bug corrections.

C.1 Version 5.4.2

- there is now a FreeBSD package thanks to David Wolfskill (david@catwhisker.org).
- Dutch language support contributed by Rob Buitenhuis (rob@buitenhs.demon.nl).
- changing the datum of all the waypoints in a group can now be made from the group window.
- conversion parameters for the "Rijks Driehoeksmeting" datum corrected (thanks to Rob Buitenhuis).
- the stereographic projection and the Taiwan grid (description made available by Dan Jacobson, jidanni@yahoo.com.tw) are now supported; descriptions of the Iceland and the Netherlands national coordinates grid inserted in the manual.
- a few more definitions of ellipsoids and datums.
- coordinates for grids not having zones are now shown with only the easting and northing fields.
- A3 paper can now be used, as well as a new date format for, e.g., "2002-02-01 16:50:40" (suggested by Anto Veldre, anto.veldre@tllapt.ee).
- for adventurous users knowing Tcl/Tk: if there is a file named `patch.tcl` in the GPSMan user directory, it will be loaded just after all the GPSMan source files have been loaded (suggested by Slaven Rezic, slaven.rezic@berlin.de).
- enhanced Lowrance support and documentation by Brian Baulch (baulchb@hotkey.net.au).
- Garmin support: conversion of floating-point numbers in Tcl/Tk depends on the machine architecture and is now checked, the user being warned if there are problems; this will not be the case with little- or big-endian machines with IEEE standard floating-point numbers; i.e., most of the computers currently in use; problem solved with the help of Dragan Milicic (dragan@math.utah.edu).
- last but not least, there is now a separate program to convert the routes listed in HTML pages of the MapsOnUS site into GPSMan files; at its core is code contributed by Frank Kujawski (Frank@Kujawski.org); a better scheme for naming waypoints is being devised.

C.2 Version 5.4.1

- support for French, contributed by Valère Robin (valere.robin@wanadoo.fr).
- new option to control how track points should be numbered when a track is displayed on the map, in answer to a suggestion by Valère Robin.
- new position format: Maidenhead locator coordinates, suggested by Harald Stauss (harald.stauss@web.de).
- (approximate) computation of area enclosed by route, in answer to a different demand by Alexandre dos Santos Cristino (alexsc@rge.fmrp.usp.br).
- it is now possible to make clusters of waypoints, using waypoints in a group as centres and by giving either a quadrangle by ranges in latitude and longitude, or (much slower) a distance range.
- new pre-defined projection: American Polyconic.
- changes allowing for speed-ups when reading/writing/displaying data.
- support for Garmin receivers provides now explicit support to the GPSMAP 180 model (tested by Rolf Hatt, rolf@hatt.com) and to the eTrex Vista (tested by bmax@gmx.it).

C.3 Version 5.4

- the preferences file is now kept under a user data directory that will also contain other files generated automatically by GPSMan (such as those for keeping user-defined projections); GPSMan will try to create this directory on Unix/Linux systems when running 5.4 for the first time.
- in Unix systems there is a new option with the path to a serial port device to be used as default; in Debian systems users must belong to the group owning the serial port device (normally `dialout`).
- Alessandro Palma (alpalmas@tin.it) contributed code that provides elevation graphs for routes and tracks.
- there are new operations on routes: chopping head or tail, including a route before or after the selected waypoint, and clearing all waypoints.
- a route can be now converted into a track (suggested by Urs Forster, forster@bluemail.ch).
- a waypoint shown on the map can be moved to a different place, changing its coordinates (suggested by Stefan Heinen, stefan.heinen@djh-freeweb.de); the operation is started from the waypoint map menu obtained by pressing the `Control`-key and clicking the mouse left-button (this used to be only the right-button).
- as also suggested by Stefan Heinen, the creation of a route on the map has been extended to a more comprehensive set of edit operations, described in detail above (4.9); this now includes editing on the map a previously defined route; moving a waypoint on the map, automatically adjusts the routes it belongs to; when drawing a route on the map a waypoint cannot follow itself.
- when editing a waypoint, renaming is no longer forbidden if the waypoint belongs to the route being edited; changes affect the information in any relevant route window.
- when reading items that are displayed on the map, the map is updated and edit/show windows are re-opened with the new data.

- all the waypoints in a group can have their position format changed to a selected format (in answer to Dan Jacobson, jidanni@kimo.com.tw)); if one of these waypoints is being edited, this change will revert its position to its initial value.
- it is now possible to inspect datum and ellipsoid definitions and create new datums and ellipsoids; a few new datums and many variants of old datums were added to a total of 247: see above (4.11) for *important* information on this; new data structures and faster code are used (based on a suggestion by Stefan Heinen).
- there is now support for user-defined particular cases of projections and coordinate grids; a few new projections were implemented (including Lambert Conic Conformal, Mercator and Cassini-Soldner); coordinates of waypoints created on the map will be given in the format chosen for the map cursor coordinates, defaulting to UTM/UPS if the format is a grid and the coordinates are out of the grid range.
- the state of program can now be saved when exiting and will be restored automatically; there are two new options to control this under the `Files` sub-window of the `Options` window; a new GPSMan format for files is used to save map parameters when there is no background image.
- the `GPS receiver` button is now a menu-button whose first menu entry replaces the previous button and the other entries provide most of the functionality of the receiver window (suggested by Stefan Heinen).
- there is now a `Clear` menu-button in the map window similar to the `Display on map` one (in answer to Dan Jacobson).
- the real-time record window was redesigned for use in smaller screens; its columns with empty first values will be collapsed automatically.
- the procedures for opening files now support MS-Windows volumes.
- changing the format of the position of a waypoint is now made keeping the internal representation of the position, to avoid conversions for the sake of accuracy.
- the single document that was used to prepare the WWW pages and the user manual has been split; the user manual is now made available also in HTML (as asked by Dan Jacobson), and has an index; the PS and PDF versions also have a table of contents; the WWW pages have been simplified and redesigned. Portuguese documentation is no longer supported.
- non-ASCII characters in file `util.tcl` caused problems in some computers (as reported by Dan Jacobson) and were moved to a new file that is only compiled if the option on composition of characters is selected.
- up- and down-arrow keys scrolled the map in the wrong direction (reported by Dan Jacobson).
- the binding of the `Return` key to the `Cancel`-button in the real-time record window is no longer active (suggested by Harald Koenig, koenig@tat.physik.uni-tuebingen.de).
- slight change in the code for providing support to USB serial ports under Linux (tested by Harald Koenig).
- support for Garmin receivers has been enhanced by a simplification of the low-level communication procedures (more reliable under MS-Windows), and by providing explicit support to the following models: eTrex Venture (tested by William Sowerbutts, willmyatsowerbutts.com), eTrex Legend (tested by Frank Kujawski, Frank@Kujawski.org), 12CX (tested by Marko Hyvärinen, mth@sun3.oulu.fi), and eTrex Mariner (tested by Max Spring, mspring@cisco.com).

C.4 Version 5.3.1

- when creating a route in the map, clicking on a place where there is no waypoint creates a new waypoint automatically — suggested by Stefan Heinen (stefan.heinen@djh-freeweb.de).

C.5 Version 5.3

- real-time logging and a moving map; the details depend on which communication protocol is used, as described above (4.14).
- coordinates for the following national grids: British (BNG), Portuguese (CMP), German (GKK), Irish (ITM), Finnish (both KKJP and KKJY), and Swedish (SEG); permission to translate code in GPStrans was granted by Janne Sinkkonen (janne@iki.fi) for KKJY and by Anders Lennartsson (anders.lennartsson@sto.foa.se) for SEG.
- several more datums; the current number is now 144.
- balloon help in limited use: for showing the track name and number of each track point in the map, in answer to a different suggestion from Urs Forster (forster@bluemail.ch), and in the real-time logging record window (variant for Garmins).
- new `Display on map` button for displaying any item not mapped, in answer to a different suggestion from Harald Stauss (harald.stauss@web.de).
- new `Clear` entry in the menu that pops up with a right-button on a waypoint on the map.
- conversion of tracks into a waypoint taking the averages of the latitudes, longitudes and altitudes of the track points; this will be useful for obtaining more precise coordinates for a waypoint by recording a track with the receiver standing still; implemented in answer to a suggestion by John Madore (madore@physik.hu-berlin.de).
- when asking for a new name after a name with non-acceptable characters is read, the new name cannot be already in use.
- "single" main window no longer supported.
- support for Garmin receivers: at the time of writing there have been still no changes in the Garmin specifications document which is known to be outdated. A problem was detected with a Garmin GPS 12Map that sends some packets twice. This has been solved by discarding repeated packets, under control by a flag in the code; thanks are due to Kyle Grieser (yuf@phoenixdsl.com) for all the tests.
- the format for image information files used before version 4.0 is no longer accepted; conversion from it to the present one should be made with any version between 4.0 and 5.2.
- last but not least, there is now a separate program to convert the waypoints listed in HTML pages of the MapBlast site into GPSMan files; at its core is code contributed by Martin Ostermann (Aachen University of Technology).

C.6 Version 5.2

- when building a route in the map window, cancelling the operation is now made with shift-middle button instead of just middle button.
- waypoints have a new field, altitude in meters; route windows present the difference in altitude between consecutive waypoints.

- there is now a `Locate` menu-button in which an item displayed on the map can be selected forcing the map to be scrolled so that the item appears in the centre — suggested by Stefan Heinen (stefan.heinen@djh-freeweb.de) and Kyle Grieser (yuf@phoenixdsl.com).
- animation of the movement corresponding to a track on the map window; this is a tentative implementation that is being extended to a "moving map" with real-time track logging.
- the map window can now be panned by dragging the mouse with the middle button down, and scrolled in the NE-SW and NW-SE directions by using the arrow keys with shift.
- the arrow that shows the map scale can now represent less than 1 unit of distance — suggested by Russell Senior (seniorr@aracnet.com). Conversion from km to m and from mile (either nautical or statute) to ft will be done in that case. In the `Options` menus the `Window geometry->Map scale` entry should be set to the desired value but only if the `Units and formats->Distance` entry has already been correctly set in a previous session.
- waypoint data in Fugawi export format can now be imported (thanks to Niki Hammler, http://www.nobaq.net, who wrote a Perl script to make the conversion).
- GPSMan format for data files has changed slightly in what concerns waypoints (new attribute-value pair for altitude) and tracks (fields for altitude and depth). Files in the previous format are still accepted.
- support for Garmin receivers: there is now explicit support to Garmin eTrex Euro (from tests done by Harald Stauss, harald.stauss@web.de), Garmin eTrex Summit (from tests done by Stefan Heinen, stefan.heinen@djh-freeweb.de), Garmin GPS III+ (from tests made by Jonathan Pennington, john@coastalgeology.org), and Garmin 12XL with software version before 3.01. Errors in the input/output of hidden information were detected and solved (thanks to Harald Stauss, harald.stauss@web.de).

C.7 Version 5.1

- support for German provided by Andreas Lange.
- support for Italian provided by Alessandro Palmas.
- German Grid projection (GKK: Gauss-Krueger-Koordinatensystem; description made available by Andreas Lange).
- change in the rules about comments on GPSMan data files.
- correction to the character set used on the Lowrance receivers by Brian Baulch.
- explicit support for the following Garmin receivers: eMap and GPSMAP 295 (thanks to tests by Edouard Lafargue and Jim Wang).
- correction to the route header transfer protocol for the Garmin eTrex (thanks to Frank Jordan).
- treatment of "delete window" events from the window manager.

C.8 Version 5.0

- it is now possible to ensure that all the information got from a GPS receiver will be kept internally and in saved files so that it can be sent to the same receiver model without loosing data. This is related with the concept of "hidden information" that is discussed above (4.3).

- when reading in data items, items with the same name in the data-base can now be either overwritten, as in previous versions, or kept and the new ones renamed. A new option controls this behaviour. Waypoints with the same position are dealt with differently. See above (4.2) for the details.

- routes have now information on the route "stages" between each waypoint. For the time being it consists of a comment and a label, plus hidden information. The label will appear in the map near the line that joins two waypoints.

- track points have now fields for the altitude and the depth in meters. Computation results have two more fields for each track point: cumulative distance to next point, and altitude in meters (a negative number means depth instead).

- computation results for a track include now the cumulative distance from the beginning and the altitude (if available) in meters for each track point.

- names dynamically created for tracks are no longer dependent on the current date, what may speed up reading them.

- the GPSMan data file format has been extended to accomodate the new data (hidden information, route stages, altitude and depth of track points). The previous format is compatible with the new one.

- names of waypoints are now checked when they are read from a file or from the receiver. If they contain characters not allowed the user is asked for a new name. The test depends on the receiver's brand. Lowrance names can have spaces but their use in files is not recommended for compatibility.

- Brian Baulch improved the implementation of the communication with Lowrance receivers, the baud rate is now 19200.

- support for Garmin receivers has been enhanced and updated. There is no need now for providing the name of the receiver model and in principle all existing Garmin receivers are supported. The model name is obtained when starting up the communication with the receiver, along with which protocols to use (if the receiver supports the Protocol Capabilities protocol; otherwise a table is looked up). The program was updated to conform with Revision 3 (6 December 1999) of the "Garmin GPS Interface Specification". All data is now recognized, although for some protocols part of it may be kept only as hidden information. Communication speed under MS-Windows is now much faster.

- Brian Baulch provided the support for using a wheelmouse in scrolling listboxes and the map.

- because of problems with some window managers, windows that were made invisible by setting their coordinates to negative values are now only lowered or raised.

Index