RW Net 4.42

A Network Analysis System SDK

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Part I

User Manual

1 User Manual

1.1 Introduction

RW Net 4.42

RW Net is a general purpose routing library. It is flexible enough to be used together with almost any GIS system available and it will also work together with most programming tools on the market.

RW Net uses it's own format for storing street networks and included are functions for importing 26 street databases from most common GIS formats. This topological format is targeted towards routing purposes and is described here 10. RW Net always loads the topological network into memory before doing any calculations.

The basic structure in the topological network is a one-to-one relationship, where the first link in the network matches the first record in your GIS file, second link matches second record etc. This makes the network files very compact and fast to use.

All attribute information (road class, one-way information etc.) is held in a separate data structure which can easily be updated without having to re-create the topological network.

1.2 Feature matrix

Features

	Standard	Pro
Network size	500,000 links	1,000,000,000 links (** 8)
Import 26	Single file only	Multiple files
Import formats	MIF, SHP, TAB	MIF, SHP, TAB, events
Import from 35 SQL database (MS SQL, Oracle, PostGIS, Geopackage)		Yes
Node-2-node routing	Yes	Yes
Matrices (*)	Yes	Yes
Spatial searches 73	Yes	Yes
Max list length (*)	300 items	No limit
Shortest / fastest / cheapest route	Yes	Yes
32 road classes	Yes	Yes
Geographic & projected coordinates 9	Yes	Yes
Alpha parameter 102 for improved speed	Yes	Yes
Output to TAB, MIF, SHP, KML, GML, CSV, DBF, array, GeoJSON, GPX	Yes	Yes
Turn restrictions	Yes	Yes
Limits 8 (max weight, width etc.)	Yes	Yes
Dynamic segmentation	Yes	Yes
Driving directions 110 (*)	Yes	Yes
Travelling salesman optimization 139 (TSP) (*)	Symmetrical	Asymmetrical too
Nearest N facilities 82 (*)	Yes	Yes
Isochrone functions - link based (*)	Yes	Yes
Isochrone functions - voronoi 116 based (*)	Yes	Yes
Export of network 49	Yes	Yes

Topological checks (subnets 101, missing snap 74, parallel links 59, cul-de-sac 47, overpasses 74 etc.)	Yes, up to 10,000 links	Yes
Encryption of network files 28		Yes
Smoothing of isochrones 120		Yes
Hierarchical routing 6		Yes
Alternative routes 105		Yes
Approach based routing 107		Yes
Multi-threaded calculation 94		Yes
TSP with curb approach 141		Yes
Mixed Rural Postman Problem (arc routing)		Yes
Join links 71		Yes
Clustering 132		Yes
Minimum Spanning Tree 98		Yes
Weighted Center of graph 96		Yes
Traffic Assignment 109		Yes

Functions marked with (*) only accepts 300 items in Standard version.

1.3 System requirements

Available for:

- .NET Framework 4.8
- .NET Core 6.0

- Delphi XE5 - XE6 - XE7 - XE8 - 10 - 10.1 - 10.2 - 10.3 - 10.4 - 11.1 (32/64-bit)

- DLL 12 for 32-bit MapInfo / MapBasic 7.5 - 15.0
- DLL 12 for 64-bit MapInfo / MapBasic 15.2.2 -

Some versions are only available in Pro version - see license terms 21.

All versions are fully self-contained and 100% "native" on each their own platform (no "wrappers").

RW Net 4 is 100% Unicode enabled.

The older RW Net 2 also includes versions for older Delphi compilers.

1.4 Quick overview

A normal setup includes these steps:

1. Import geographic coordinate data into RW Net's own format with class TImport 26
2. Import attribute information such as street names, one-way information etc. with class TImportAttributes 31
3. Open the generated files with class TNetwork 38
4. Perform spatial searches with class TSpatialSearch 73 or
5. Perform isochrone calculations (one-to-many, matrices etc.) with class TCalc 78 or
6. Perform one-to-one route calculation with class TRouteCalc 101

Routes can be exported to a lot of standard formats using one of the TGISwrite 122 classes. Several of the functions write directly to one of the GIS formats.

Drivetime isochrones

A typical use of the software is the calculation of drivetime isochrones, showing how far you can get in 5, 10, 15 minutes etc.
We have explained the various options in more detail here 16.

Optimization

Matrices can be used in one of the TSP classes (TTSP 139 and TTSPcurb 141) to perform an optimization of the sequence.

TOptimizer 132 is used for creating territories according to various criteria: Load, size etc.

1.5 Network terminology

Terminology used to describe the various elements of a street network:

A *link* consists of several connected vertices (2 or more, blue squares on the map below). The first vertex of a link is called the *from-node* and the last vertex is called the *to-node*. See function Link2FromNode 54 and Link2ToNode 54.

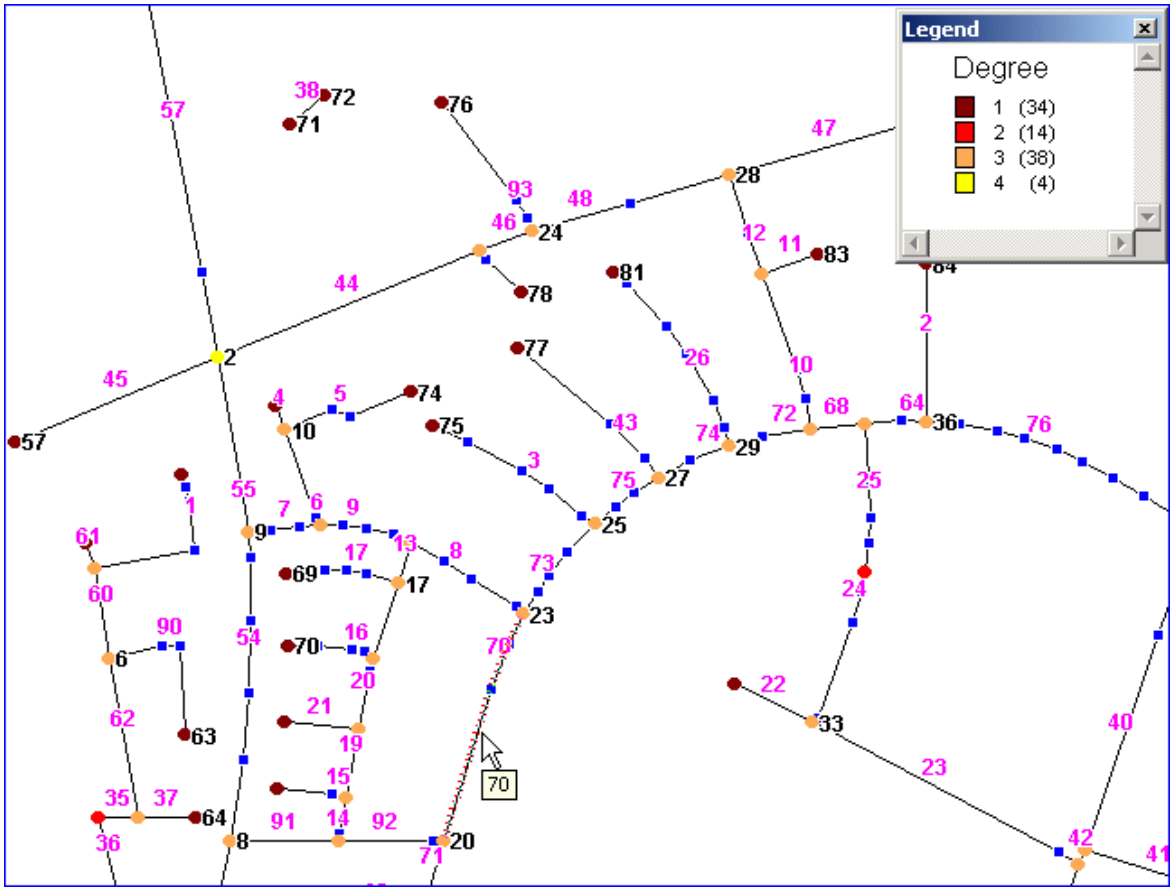
Most of the nodes share coordinates with nodes of other links. The number of links sharing a node is referred to as the degree of the node. You should normally never reach more than 10. See function Degree 47.

A node is also called an *intersection* - even if the degree is 1 or 2. A link where one of the nodes has degree 1 is called a *dangling* link. A node with degree 2 is called a *pseudo-node* (see function Join 71). The red node on the map is such a pseudo-node.

A link is identified by it's internal ID (Magenta text on the map: 1, 2, 3 ....), which corresponds to the record ID's of the input dataset used by function TImport.execute 28.

A node is identified by it's ID (Black text on the map: 1, 2, 3 ....). Node ID's are primarily ordered by degree in descending order and secondarily by x-coordinate in ascending order. Node ID's are assigned during network import and can not be controlled by the user.

A *location* is a position on a link: e.g. 50% along link 70 - counted in the same direction as that the link has been digitized in. This appr. matches the cursor on the map below. Locations are used when doing dynamic routing. The percentage needs to be between 0 and 1 (both included).



1.6 Link information

1.6.1 Attributes

The attribute for each link in the network play a key role in defining how the link is used in the routing calculations. This is defined through a bit-pattern:

1. Road class, 0-31 (5 bits)
These have no predefined meaning, but their value can be translated into a drive time using function CalculateTime 44

2. Hierarchy (*), 1-5, (3 bits, 32-64-128, bit 5-7)
A topological hierarchy can be used for speeding up TRouteCalc 101 calculations.
0 is also allowed, if you don't use the hierarchy at all.
See further explanation here: Hierarchy 6.

3. No-drive through (*), true/false (1 bit, 256, bit 8)
This can be used to define areas, where you are not allowed to drive through to get to the target.
Applies to TRouteCalc 101 calculations.
See TNetwork.NoDriveThroughCheck 57, TNetwork.NoDriveThroughInit 57 and TRouteCalc.NoDriveThrough 91

4. One-way, To-From direction not allowed, (1 bit, 512, bit 9)

5. One-way, From-To direction not allowed, (1 bit, 1024, bit 10)

If both bit 9 and 10 are set, the link is closed for driving.

6. Roundabout, true/false (1 bit, 2048, bit 11)
Can be used in creating driving directions.

7. Non-driving link, such as a ferry or car-train, true/false (1 bit, 4096, bit 12)
Can be used in creating driving directions.

8. True if not allowed to make U-turns at the From-end of the link. (1 bit, 8192, bit 13)

9. True if not allowed to make U-turns at the To-end of the link. (1 bit, 16384, bit 14)

10. SkipInSearch (*), true/false (1 bit, 32768, bit 15)
For use with function NearestLocation 75
See SkipLinks2BitArray 63 and TSpatialSearch.SkipLinks 77

(*): Changed from RW Net 2.

An example:

A road of class 4, which can only be travelled in the direction of digitization: 4 + 512 = 516.

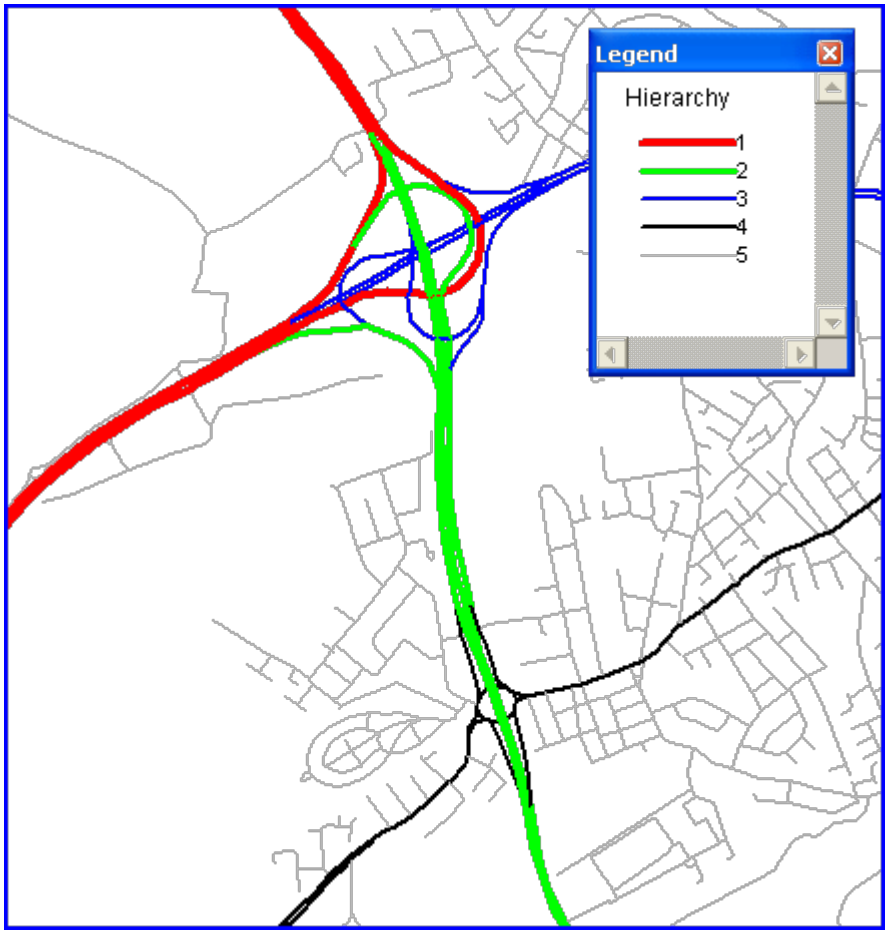
1.6.1.1 Hierarchy

Some street databases has special attributes for the most important streets, the ones being used as part of long routes.
This will typically be motorways, but can also be ferries, bridges and some minor streets which are required to have a connected network.

The advantages of restricting routes to these more important streets are:

- Much faster point-2-point route calculations for long routes (TRouteCalc 101).
- Simpler routes, which doesn't make short-cuts via minor roads to make a long route a little shorter / faster.

The map below shows an example from TomTom Multinet data with 5 layers of importance (hierarchies):



RW Net 4 uses a method where the calculation of the route is restricted to level 1..X as soon as level X has been reached on the route unless you are
within a certain distance Y of the final target. Then additional levels are included in the search again.

For the algorithm to work properly the parameter Y has to be supplied for levels 2 to 5. Level 1 (the top level) is of course always included in the search.
The best values for these parameters depend on the geometric properties of the network and how the hierarchy attribute has been setup.

If you have less than 5 levels in your data source - 3 for instance - use levels 1, 2 and 3.

If you choose small parameters values, a smaller part of the network is considered when you get close to the target and this improves calculation speed.
The downside is you risk not finding the target at all (!), because there are no major streets within the limits you have defined.
The solution to this problem is to re-calculate without the hierarchy setting or just use a more relaxed setting (larger parameter values).
Such re-calculations are costly and when choosing parameters it is important to find a balance between normal, fast calculations and the slow re-calculations.

Functions for working with hierarchies:

TNetwork.Hierarchy 54 For getting / setting hierarchy for a single link

TRouteCalc.Hierarchy 106 For enabling / disabling hierarchy for a calculation
TRouteCalc.SetHierarchy For defining parameters for the hierarchy - suggestions for TomTom and
Level 108 HERE databases

1.6.2 External ID

Each link can have an associated external ID as opposed to the internal ID (1, 2, 3...). The external ID can be either string based, integer (0..2147483647) or int64 (0.."really big") based.

The advantage is an external ID can be constant over time and globally unique - even when working with a subset of a larger database.

RW Net includes functions for translating between internal and external ID, but otherwise all functions uses internal ID for input / output.

If you are using external ID's there are additional limits on the number of links in your network:

32-bit integer	500 million links
64-bit integer	250 million links
string	If string is 38 char GUID, up to appr. 30 million links
string, extended	1000 million links

The last option is only possible with library versions from after 3-10-2019 (RW Net 4.36 or more recent).
Files generated in such mode is >2 GB and are not compatible with older releases.

1.6.3 Limit

Besides the routing options available as part of the attribute 5 bit pattern, it is also possible to define 2 other kind of route restrictions for links in the network:

1. A scalar quantity such as a maximum weight, height, width etc. If the limit for a certain link in the network is 100 and you calculate a route for a vehicle with a value >100, that link will be avoided in the route. It is mandatory to scale your limits into the 1-255 interval.

2. A ***bit pattern*** for defining special links such as ferries, toll roads etc. which you may want to avoid in your routing. If the limit for a link is 3 = 00000011 it may mean it is both a ferry and a toll "road" (most ferries are not free, so that seems logical). If your value has either bit 1 or 2 set, that link will be avoided in the route. It is possible to define 8 such bits within each limit.

For both types, a link value of 0 means no limitations at all.

A maximum of 9 such limitations can be created.

See TImportAttributes 31, TNetwork 38 and TCalc.SetLimit 62.

1.6.4 Road name

It is possible to have a road name for all links. Multiple sets can be created so a link can have the name "Main Street" in one setup, but "Main Street, Smalltown" in another setup. Or use different languages.

Road names are stored using Unicode and always converted before output, depending upon the chosen file format and codepage.

Road names can be used in driving directions 110 and in functions ExportLinks 49 and Join 71.

1.7 Turn restrictions

There are 2 types of restricted turns:

- Banned turns
- Delayed turns

Normally you will be using banned turns only, since for most normal routing purposes, setting different road speeds for road classes are sufficient for giving a realistic route choice.

Generally you can change choice of route A LOT by using wrong values for delays, so take care.

All methods about turn restrictions has an index parameter, which points to one of the turn indices, created by CreateArrayTurn 47.

If you add a turn restriction, where one of the links making up the restriction is already marked as one-way, it is skipped.

See TNetwork.TurnImportTXT 67 for the text format to use for import.

1.8 Coordinate units

Two kind of coordinate units are supported:

- Spheric / Latitude-longitude (global / local)
- Cartesian / Projected (local)

When working with spheric coordinates, all distance calculations are performed using great circle distances and the Earth is considered a perfect sphere with radius 6378.13 km.

When working with Cartesian coordinates, all distance calculations are performed using straight Pythagoras formula. Several different Cartesian units are supported.

Global projections such as Web Mercator and more are not supported. They use meters as coordinate unit, but the scale factor depends upon the latitude.
If you use it, you will not get any error messages, but the lengths will come out wrong, when you are not on Equator.

It is worth noting, that RW Net *never* performs any transformation between coordinate systems. It always works with the native coordinates of the base dataset used when creating the network. It will return strange results, if you set the coordinates as spheric, while they are really meters or vice-versa. It is YOUR responsibility to make sure this is correct.

See also TCoordinateUnit 155

1.9 Coordinate system

When importing 26 from a GIS street database, information about the coordinate system is stored in the INI file.

This is used for generating output files with class TGISwriter 122 - either internally or by the user.

Depending on the output formats you plan to use, this information is needed:

TAB / MIF	Coordsys clause
SHP	PRJ file
GML / GeoJSON	EPSG code
KML / GPX	Always uses lat/long, WGS 84

These should be set before importing.

1.10 Units

RW Net 4 uses metrical units almost everywhere in the setup:

- Distances: Km
- Speeds: Km/h
- Time: Minutes

The exception is miles & mph can be used in a few output-to-file functions, where the output is directly aimed at end-users:

See TCalc.DistanceUnit 80, TVoronoi.MilesOutput 120 and TDrivingDirections.DistanceUnit 112 if you prefer miles.

1.11 File structure

When a network is imported, several binary files are created on disk, which together define the topological network. This gives a short description of the content of the various files:

Filename	Mandatory	Encrypted	Explanation
Attribute.bin		X	Attributes of links
Coord.bin	X	X	Coordinates of all intersections (start / end node)
Coord3.bin	X		Coordinates of the rest of the vertices
Coord3i.bin	X	X	Index into Coord3.bin
Index1.bin & index2.bin			Index for conversion between link id (1, 2, 3..) and external id.
Length.bin	X	X	Length of all links in the network
Limit?.bin		X	Information about limits on links such as max heights etc.
Link.bin & node.bin	X	X	Information about link-node relationship ("topology")
Roadname??.bin			List of possible road names, Unicode
Roadnumber??.bin			Index into roadname??.bin
Rwnet_config.ini	X	X	INI file, text format
Spatialindex.bin			Spatial index of both links and nodes

Turn restrictions can be stored in files with flexible naming.

If you set the Encryption 28 property, files marked as such in the table will be encrypted during creation and decrypted during load.

1.12 Password protection

You need to enter a password when using a non time-limited version of RW Net.

Call method InitPassword for any of these classes after instantiation:
TImport 26, TNetwork 38, TTSP 139, TTSPcurb 141

It is sufficient to supply the password *once* in an application.

1.13 Progress events

Progress events are available for these methods:

TImport.execute 28 (+)
TImportAttributes.execute* 31 (+)
TImportSQL.executeMSSQL 36 (+)
TImportSQL.executeOracle 37 (+)
TImportSQL.executePOSTGIS 37 (+)

TNetwork.AttributeSave 43
TNetwork.ExportLinks 49
TNetwork.ExportLocationList 50
TNetwork.ExportNodes 50
TNetwork.Join 71
TNetwork.ObjectCheck 58
TNetwork.Open 58
TNetwork.ParallelLinks 59
TNetwork.TurnImportTXT 67

TSpatialSearch.FindNonConnected 74
TSpatialSearch.FindNonConnectedNodes 74
TSpatialSearch.FindOverPasses 74
TSpatialSearch.SplitAndSnap 78

TCalc.Matrix 87 (+)
TCalc.Matrix2 87 (+)
TCalc.MatrixDyn 88 (+)
TCalc.MatrixOut 88 (+)
TCalc.MatrixDynOut 88 (+)
TCalc.MatrixPOut 88 (+)
TCalc.SubNet 101

TRouteCalc.MatrixDynCurbIsoChrone 107
TRouteCalc.MatrixDynCurbRoute 107
TRouteCalc.SubNetEx 108

TTSP.execute 140 (+)
TTSPcurb.executecurb 142 (+)

TVoronoi.execute 118

Assign the OnProgress event to follow progress and eventually cancel the calculations. The events steps from 0 to 100 and as a minimum for every 2 seconds.

(+): Cancel request is supported in these methods. Check property Cancelled afterwards to check if the user cancelled.

1.14 MapBasic DLL

The rwnet4.dll is aimed for use with MapInfo / MapBasic.

Since MapInfo is a single user application, we have made several changes to make development easier.

Rather than doing Create/Free methods, we use pre-allocated objects.
Objects are referenced either indirectly (single instance) or by their index (multi instance).

Classes referenced indirectly:

- TAltRoute 154
- TAltRouteList 146
- TCalc 78 / TRouteCalc 101
- TDrivingDirections 110
- TGISwriter 122
- TImport 26
- TImportAttributes 31
- TNetwork 38
- TOptimizer 132
- TPolyGeneration 149
- TRandom 149
- TRoadClassSpeed 150
- TRoadClassTurnCost 150
- TRoute 161
- TSpatialSearch 73
- TStepList 147
- TTrafficList 148
- TTSP 139
- TTSPcurb 141
- TVoronoi 116

Classes / types referenced by index (handle):

	Number of instances	Null-element
TApproachArray 154	2	
TBitArray 148	3	Yes
TCostArray 156	2	Yes
TCurbMatrix 156	1	
TFloatPointArrayEx 157	2	
TIntegerArray 158	2	
TIntegerList 147	2	Yes
TLocationList 147	2	Yes
TMatrix 159	2	
TStringList 151	2	Yes
TWordArray 163	2	

If null-element is true, you can pass 0 as index / handle, when you want to pass nil as parameter.

Function naming convention
TImport.Execute becomes TImport_Execute.
TCalc.IsoCost becomes TCalc_IsoCost.
etc.

Some method names have been shortened due to max length = 31 characters.
TCalc 78 and TRouteCalc 101 are both referenced as TCalc.

All definitions can be seen in the rwnet4.def file along with a sample application, covering key areas.

Two versions exists:
- rwnet4_32.def for MapInfo 10.0-15.0
- rwnet4.def for MapInfo 15.2.2 and up.

Password initialization
Call method "InitPassword 11".

Codepage
Since RW Net 4 is Unicode enabled and Mapbasic isn't, it is required to do an internal conversion in all function calls involving strings.
This is handled automatically through a global variable, which sets the codepage you are using in MapBasic.
Default is the system codepage.
Methods: GetCodepage / SetCodepage.

GIS output format
There is a global variable for output format, which is gfMITAB 157 by default.
This means it is skipped from all function calls having a gisformat parameter.
Methods: GetGISformat / SetGISformat.

CharacterSet
You can get the current codepage for your table by calling function CharSet2CP, where you pass the return value from TableInfo(tableid,TAB_INFO_CHARSET).
Then call TNetwork_SetCodepage 46 to define which codepage is used in all output - also from TDrivingDirections etc.

Colours
Colours are read/set directly in MapInfo colour format (RGB <> BGR), while the .NET and VCL versions uses windows colour scheme.

Error handling
If an error happens when calling a method, you can use one of these 2 functions to test it:
GetLastExceptionClass
GetLastExceptionMessage
The messages are cleared after each successful method call.

Progress Events
These can all be turned on/off by calling ShowProgress with 0/1 as parameter.
The progress is then shown with a built-in dialog.

Missing functionality compared with VCL / .NET version
- GISarray 81 output as format

- Direct access to TPolyGeneration 149

1.15 TAB files

TAB files are the native file format of MapInfo Professional.
Two main versions exist:

- The original TAB, allowing up to 2 GB files.
- The extended TAB (TABx), without this limitation and allowing unicode for strings.

RW Net 4 reads both of these natively and can also update them natively (attribute information), but writing them from scratch requires a 3rd party library:

MITAB
This is an open source and free library able to write TAB files.
Find it on RouteWare website, download section.

EFAL
This is Preciselys free library, able to write TAB and TABx files.
Find it here: https://support.precisely.com/product-downloads/item/mapinfo-efal-sdk-download/

MFAL
This is Preciselys library, able to write TAB files.
Not publicly available.

All 3 exists in both 32 and 64-bit versions.

Large datasets
MITAB and MFAL are both very fast, while EFAL easily uses 10 times as much time on the same dataset.
In fact, it may be faster to write to MIF and then leave it to MapInfo Pro to import from MIF to TAB.

1.16 Data Sources

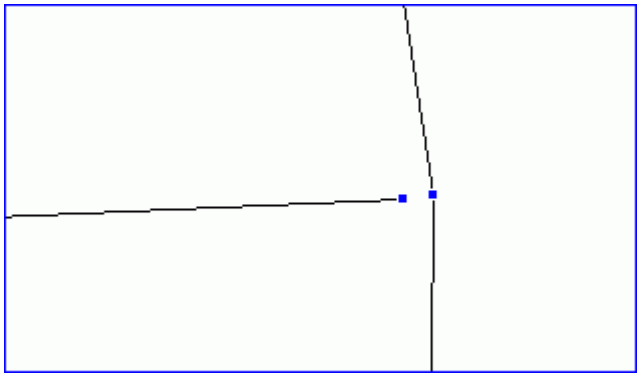
At RouteWare website you will find a list of street data providers for various parts of the world. Data from these providers usually have a topological correct structure, which means they are almost ready to be used in RW Net.

But how should your own street data look like, in order to be used in RW Net?

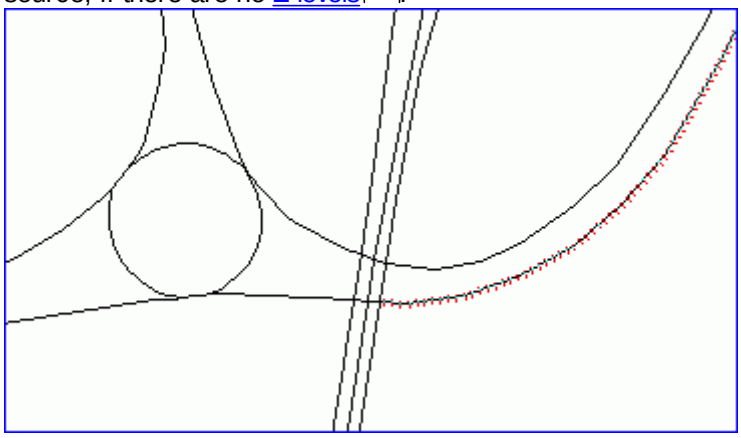
- ***They need to snap***
- ***They need to split at intersections***
- ***The network should be plane unless there is an overpass***
- ***You should avoid subnets (islands)***
- ***You should avoid very long links, which have a negative impact on speed of certain calculations***

Below is shown some examples on networks, which are NOT correct, but all look correct unless you check out the details:

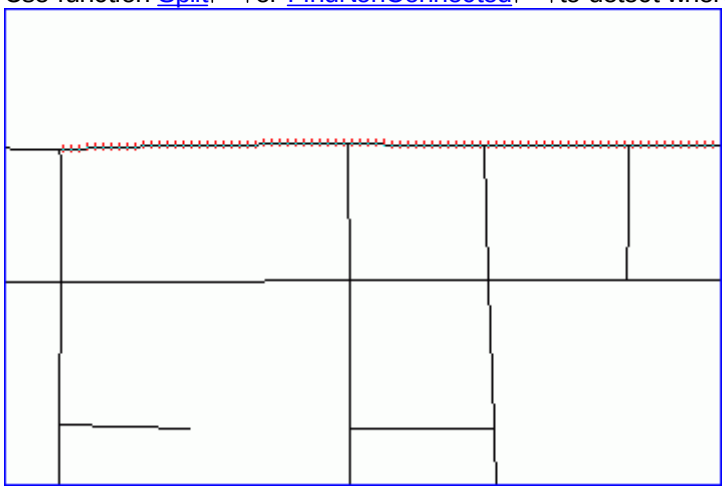
Example 1: Missing snap at an intersection
This means the network doesn't connect and the movement to / from the disconnected section, isn't possible. In the example below, the gap is just 1 meter and can't be seen at normal zoom levels. Use function FindNonConnected 74 to detect these situations.



Example 2: Split at overpass / underpass
This means a lot of impossible turn movements are suddenly made possible. This is a typical problem with TIGER data.
There is no single logical check to detect these situations, it is a simple shortcoming of the data source, if there are no Z-levels 16.

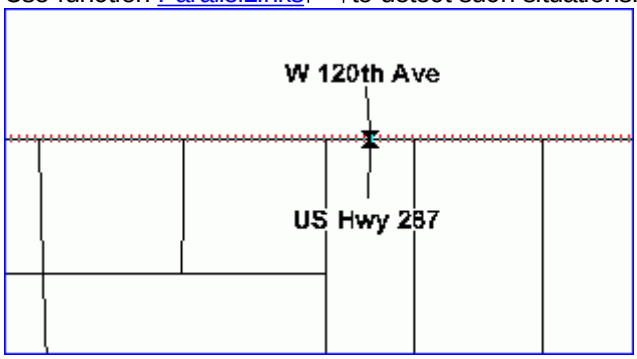


Example 3: Doesn't split/break at intersections
This means turns are not possible at most intersections.
Use function Split 78 or FindNonConnected 74 to detect where this is most likely an issue.

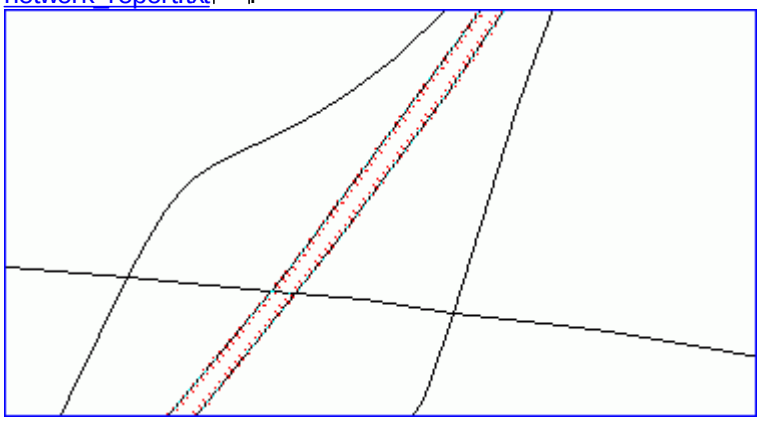


Example 4: Double digitization with two street names, here name + route number
Not a really big problem, but the result of a route calculation may include one of the two streets in a more or less random fashion.

Use function ParallelLinks 59 to detect such situations.



Example 5: Multi sectioned polylines
Polylines with more than 1 section are ignored. They will not be part of any route, since there is no logical start/end of the link.
These will be reported during network import in either ImportErrorList 29 or in the network_report.txt 28.



1.17 Z-Levels

Z-level is an integer from -9 to 9, which specifies the vertical level of streets: One number for the start of the link (Z-from) and one for the end of the link (Z-to).

The information is used during the import 26 process to adjust coordinates slightly (10 cm) to prevent nodes at different Z-levels to have the same coordinates. The modification is only applied, if Z-level<>0.

It is commonly found in commercial street databases (HERE, TomTom, ITN etc.).

If your dataset contains fromnode and tonode for the links instead of Z-level information, use ExternalNodeId2ZLevels 51 for a transformation.

1.18 Isochrones - overview

Generating nice-looking isochrones has always been a key functionality of routing software and RW Net 4 offers several methods, which are shown below.

As you will see, generating the same N km isochrone with different methods do not give the exact same output.

That is also why we generally do not recommend using the isochrones for point-in-polygon analysis as a way of finding out which customers are less then N km away.

Rather use the various matrix functions for finding distance between multiple points. This also allows you to include the off-road part in the calculations.

This table gives an overview of the key differences between the methods:

	DriveTimeSimpleDyn 80	Voronoi 116	IsoLinkDriveTimeDyn 83	IsoLinkDriveTime 83	Alpha shapes 96
Input	1 location	nodes & locations	1 location	nodes	nodes & locations
TPolyGeneration input		Yes			Yes
Speed of calculations	36 ms	47 ms	78 ms	109 ms	125 ms
Holes		Yes			
Islands		Yes			Yes
Doughnut mode	Yes	Yes			
Smoothing	Yes	Yes			
Shown on map as:	Blue line	Yellow polygon	(not shown)	Black network	Brown line

Alpha shapes and DriveTimeSimpleDyn both tries to follow the perimeter of the network, which can be reached from the starting point(s).
They do not take into consideration any unreachable parts of the network (the grey lines), so they may get included in the output polygon anyway.

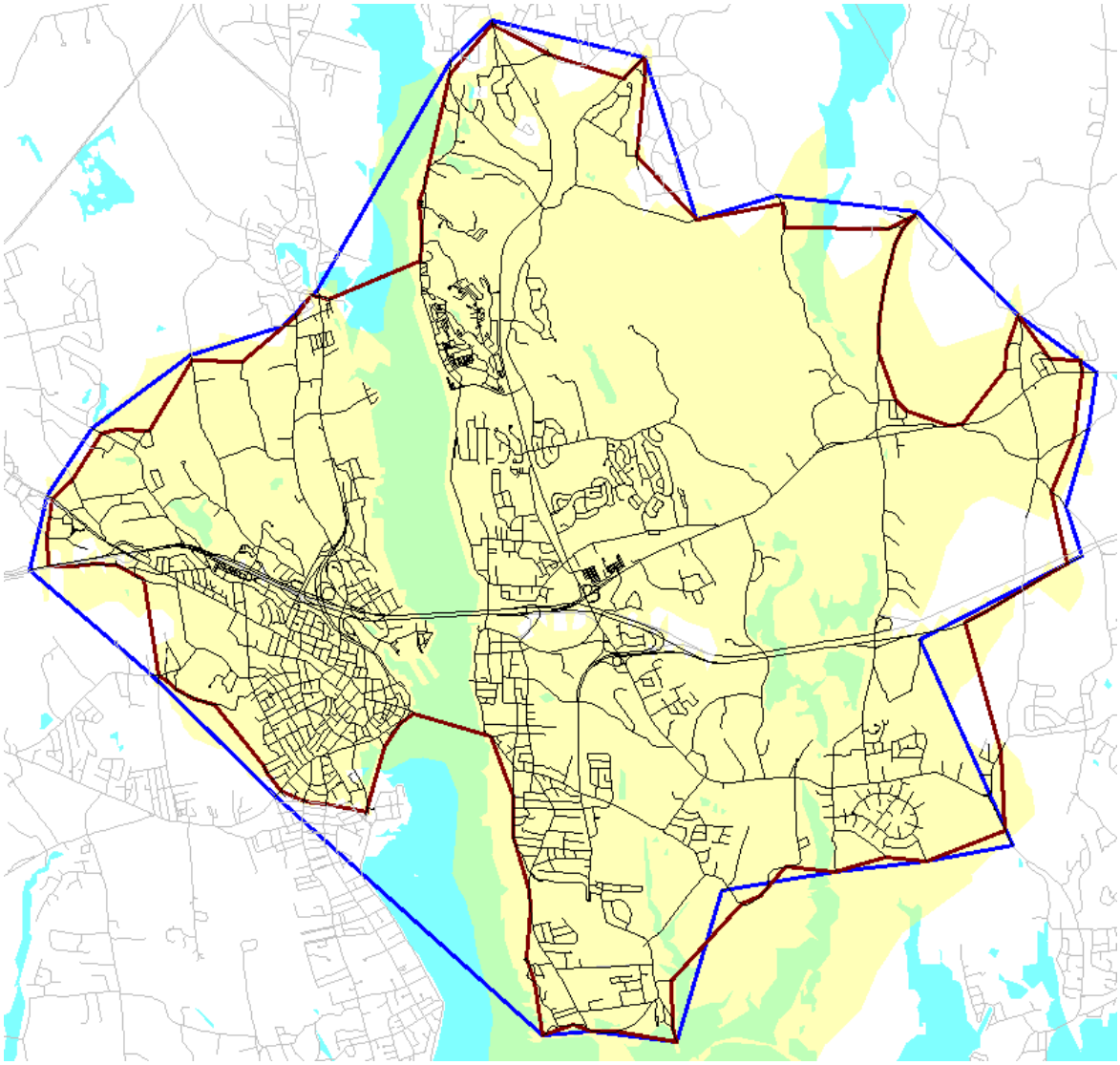
Voronoi on the other hand follows the line between what can be reached (black network) and what can not be reached (grey network).

Alpha shapes can not be calculated in doughnut mode, since 2 polygons may actually be intersecting, due to the way they are calculated.

IsoLinkDriveTime(Dyn) is the most accurate, so for comparison it is included. But it is a much different kind of output.

Timings above are for the 7 km isochrones shown below with addnodes = 0.3 km 86:

NOTE: Has not been updated, after the performance improvements in version 4.30.



1.19 Check List

Sometimes a calculation returns a different result (route) compared to what you expected or you get no route at all. Both situations are due to issues somewhere in the network and these can be hard to locate.

This is a list of things to check:

- Look inside network_report.txt (generated when calling TImport.execute 28):

1. Are you using the latest version of RW Net?
2. Is the coordinate unit detected correctly?
3. Should Z-level information have been applied?
4. Do some of the objects have errors?
5. Is the average object length realistic?

- Check for network errors. See also data sources 14.

- Reduce the setup as much as possible:

1. Call Open 58 (false,false,false,0) (removes one-way restrictions)
2. Set Turnmode = false, when creating TCalc instance
3. Set Hierarchy 106 = false
4. Skip Limits 93
5. Use SetShortest 93
6. Set Alpha 102 = 0
7. Set NoDriveThrough 91 = false

If this solved the problem, enable these again one by one, until it fails. Then you know where to look.

- Create maps in your GIS identifying the problem:

1. Look at basic map for no physical connection (missing bridge / ferry etc)
2. Create a thematic map of one-way directions and closed links
3. Create a thematic map of attribute field
4. Create a thematic map of hierarchy attributes etc.
5. Call TurnExportGIS 66 to view turn restrictions
6. Call FindNonConnected 74 from RW Net Pro
7. Call SubNet 101 from RW Net Pro

If you have multiple points (Matrix or TSP function), it can be tricky to locate which point makes the trouble. One method is to calculate with 2 points first. If that works OK, try with 3 points, then 4 points etc, until the problem pops up. Now the problem is usually somewhere near the last point being added.

1.20 0 / 1 - indexing

This list helps you when writing code, when to use 0 or 1 as base for indexing.

0 - indexed
All lists
Field number when reading from DAT / DBF
ZFromField / ZToField
TimeArray index
CostArray index
TurnArray index

1 - indexed
link id's
node id's
LimitFileIndex (1-9)
RoadnameFileIndex (1-99)

1.21 Changes from RW Net 2

This list is not being updated anymore, since RW Net 2 is now so long time ago.

New functionality

Full Unicode support
Improved .NET support (Compact Framework and Mono for instance)
Nodes can be "closed" in point-to-point routing
Links can be "closed" in point-to-point routing (No-Drive-Through bit)

Complex turn restrictions
Automatic identification of left/right turns
Travelling salesman optimization with support for curb approach
Travelling salesman optimization with time windows
Output to array format instead of files on disk (known from RW NetServer 3)
Minimum spanning trees

Improved functionality

Better developer experience (more OOP)
Improved flexibility
Much faster spatial searches
Overall calculation speed

Changes in behaviour

Loop links are not allowed by default.
Networks with loop links do not work in route calculations (TCalc, TRouteCalc, TDrivingDirections).
Starting 1-1-2012.
Percentages in locations can now also be exact 0 or 1. No need to use 0.0001 or 0.9999
Side in locations are defined differently
The attribute field is differently defined for a few of the bits ("mode" is gone)
Alpha parameter is by default 1 (enabled)

Changes in setup

File format is different with an INI file introduced (can be replaced with an event if desired). Even though some file names may be the same, the content may be changed
Road names are now stored in Unicode format, making import/export easier
Coordinate system is normally detected automatically during import
Coordinate system don't have to be specified when opening network, since it is stored in the INI file
Routes modes are now shortest, fastest or cheapest - it used to be shortest or fastest/cheapest
Distances, speeds etc. are in km (SI-unit). Miles can only be used in a few output-to-file functions
Password for initialization is now also needed in the Delphi versions.

Functions removed

Isogrid
NWcreateCGF
ResultFile & ResultSave
RouteSave
All functions listed as obsolete in RW Net 2 documentation
COM version

Functions renamed

AirDistNode: DistanceBetweenNodes 48
AirDistPos: DistanceBetweenPoints 48
AttributeCreate(2): ExecuteAttribute 33
AttributeLoad: Open 58
Assignment: TrafficAssignment 109
CloseLink: OneWaySet 58
Coordinate2Location: NearestLocation 75
Coordinate2LocationSimple: NearestLocationSimple 76
Coordinate2Node: NearestNode 76
CulDeSac: CulDeSac 47 & SubNetEx 108 & Bridges 106

District: District 136
ExternidImport: ExecuteExternalidInt 33 / ExecuteExternalidString 33
ExternIDfindID: Link2ExternalID 55
ExternIDfindIndex: ExternalID2Link 51
FindCloseNodes: FindNonConnected 74
GetLinkDist: LinkLength 55
GetOpenStatus: OneWayGet 58
IsoLink2: IsoLinkDriveTime 83
IsoLink2Dyn: IsoLinkDriveTimeDyn 84
IsoLink4: IsoLinkServiceArea 84
IsoPoly2: TVoronoi 116 with mode = vmIsoChrone
IsoPoly3: TVoronoi 116 with mode = vmSimple
IsoPoly4: TVoronoi 116 with mode = vmServiceArea
LimitCreate: ExecuteLimit 34
LimitLoad: OpenLimit 59
LimitLoad_bitpattern: OpenLimit 59
Linkmax: Linkcount 55
NetworkCenter: CenterNode 96 / Cluster2 134 / Cluster3 135
NetworkLength: Length 54
NodeCreate: ExportNodes 50
NodeLinkCheck: FindNonConnected 74
Nodemax: Nodecount 57
NodeX, NodeY: Node2Coordinate 57
NWcreate: TImport.execute 28, ExportNodes 50, ObjectCheck 58
NWload: Open 58
NW3Dnodes: ExternalNodeId2ZLevels 51
Overpasses: FindOverPasses 74
RoundAbout: AttributeGetBit 43(link,11)
RouteList: TDrivingDirections 110
UnusedLinks: UnusedLinks 101
Valency: Degree 47

1.22 License Terms

Platforms

A license gives access to available versions as listed in the schema below. Within the first year licensor has access to updates and new versions.

	Standard	Pro
.NET	Yes	Yes
DLL for MapInfo / MapBasic	Yes	Yes
Delphi XE5 - XE8, 10.0 - 11.1, 32 / 64 bit	Yes	Yes

Support

A license gives access to support as listed below for the first year:

	Standard	Pro / Standard site
E-mail support	ASAP after 24 hours	ASAP
Telephone / Skype support		Yes

E-mail support includes answering questions, which do not involve writing source code of >10 lines. Only persons with a license can receive support.

After first year, support and maintenance can be extended for one more year at a time.

Deployment / distribution

This table lists how deployment of applications is allowed for different versions of RW Net:

	Standard	Pro
Deployment of desktop applications	Only within own organization	Allowed
Deployment of server application	See website for price	See website for price
Deployment of TImport 26 functionality	See website for price	See website for price

It is a server application if:
- The application has an API, which makes the routing functionality accessible from other applications or
- The routing functionality is available from other computers through a network (web service, REST, cgi etc.)

General terms

Licensor is allowed to use RW Net for as long as he/she doesn't violate this license.

Licensor is not allowed to:

- Distribute applications outside it's own organization, which competes directly with RouteWare's own applications: RouteFinder, RW NetServer and FleetEngine.
- Wrap up RW Net in component-like structures and distribute it.

If licensor holds a personal license, he/she can either:
1) Have only 1 named person using RW Net on as many computers as he/she like or
2) Install it on 1 physical computer (doesn't include terminal services, citrix and similar setups) and let several persons use it from there (support is still only given to 1 person)

If licensor holds a site license, it allows an unlimited number of persons at licensors site to use RW Net at the same time. Ask RouteWare for enterprise-wide licenses.

Licensors of RW Net are issued a personal password 11 to activate the software. This password must not be readable to end-users of deployed applications. It is the responsibility of licensor to ensure that this is taken care of.

The usual legal stuff

All copyrights belong to RouteWare (Uffe Kousgaard).
Disassemble or reverse engineering of RW Net binaries are not allowed.
Licensor is not allowed to install RW Net on a network drive or shared drive except for backup purposes.
Licensor is not allowed to sell or in any other way hand over the right to use the software to any other party.
RouteWare is not responsible for any problems, direct or indirect, which RW Net may cause - no matter what the reason may be.
Any problem / error will be corrected as fast as possible within normal business hours. If RouteWare is not able to correct problems, which to a severe degree affect the functionality of the software, a refund is made, which matches the degree to which the software doesn't function properly. This refund is based on what the licensor has paid within the last 12 months and cannot exceed this amount.

Updated Jan 2014

Part II

Main Classes

2 Main Classes

2.1 TImport

These classes (TImport & TCustomImport) are used for importing the main geography part of a network.

Using this class in applications that you deploy to other users, requires an additional runtime license. See license terms 21.

TImport
Add 26
AddFiles 27 (only available in RW Net Pro)
Execute 28
ZfromField & ZtoField 31 *

TCustomImport (only available in RW Net Pro)
Execute 28
OnImportLink 30 *

Shared properties / methods:
AllowLoops 27 *
CoordinateUnit 27 *
CoordSys 28 *
Directory 28 *
EPSG 28 *
Encryption 28 * (only available in RW Net Pro)
MaxNodesPerCell 29 *
PRJ 30 *
SkipSpatialIndex 30 *

CreateReport 28
ImportErrorList 29
LinkCount 29
MaxDegree 29
MBR 29
NodeCount 29
StartTime 30
StopTime 30
TotalLength 30

* = Properties that may be set before calling execute 28. Default values are sufficient in most cases.

2.1.1 Add

Call this method to add a single file to the list of files for processing by Execute 28 method.

Adding a TAB file requires that the corresponding MAP and ID files are also present.
Adding a SHP file requires that the corresponding SHX file is also present.
Adding a MIF file requires no further files.

You can not mix different file types.

Extended TAB files from MapInfo 15.2 (64-bit) and onwards ("NATIVEX") are supported.

Syntax: Add(filename: string)

In RW Net Standard you can only add 1 file in total. If you add another one, the previous one gets removed from the list.

2.1.2 AddFiles

This method can be used to add 26 multiple files at a time.

Syntax: AddFiles(files: TStringList 151)

Only available in RW Net Pro.

2.1.3 AllowLoops

This property can be used to define if loop links are allowed in datasets. A loop link is one, where the first and last vertex is the same.

If AllowLoops is false (default), loop links will be reported 29 during the import process.

If AllowLoops is true, the existence of any loop links will prevent the use of TRoute 161, TRouteCalc 101 and TDrivingDirections 110.

We recommend that loop links are split into 2 links in advance.

Databases without loop links: TomTom, HERE, OSM, ITN and Meridian 2.
Databases with loop links: NVDB and DAV.

Type: Boolean

2.1.4 Cancelled

You can check this read-only property after calling Execute 28.
If true, the user stopped the process.

Type: boolean

2.1.5 Clear

This method will clear the list of files.

2.1.6 CoordinateUnit

Coordinate unit will automatically be detected for MIF and TAB files.
For SHP files it will happen automatically if a PRJ file exists.

For other situations, it should be set by the user or an error will be raised during import.

Default: cuUnknown

Type: TCoordinateUnit 155

2.1.7 CoordSys

This string property is a MapInfo coordinate clause.

If you import from a MIF or TAB file, it property will automatically be set during execution.

You can set it manually, if you plan to export to MIF or TAB using TGISwrite 122 or one of the other functions writing to GIS files.
Otherwise it will be set to a default value (Non-Earth coordsys) that matches CoordinateUnit 27 and the coordinates in the file.

Type: String

2.1.8 CreateReport

Call this method after calling execute to generate a report on the import process. This is similar to the report from RW Net 2.

Filename is always network_report.txt and it is stored in the same folder as the other bin files.

Syntax: CreateReport

2.1.9 Directory

This property points to where the output files are stored.

Default: Current directory.

Type: String

2.1.10 EncryptionKey

You can set this property if the imported files should be encrypted to prevent other users from using the files. Encrypting makes it harder, but can't fully prevent the very determined and skilled user from getting to your data.

Default value is 0 (no encryption). You can only set it in RW Net Pro.

Type: Int64

2.1.11 EPSG

The EPSG code should be set before importing, if you plan to export to GML files later on.

Default value is 4326 (Lat/Long, WGS84).

Type: Integer

2.1.12 Execute

Call this method when you have defined all input parameters. This is what does the main job.

Syntax: Execute

2.1.13 FailOnDifferentCoordSys

This property is used for controlling import of multiple TAB or MIF files.

If true (default), it will stop when different CoordSys' are encountered.

Type: Boolean

2.1.14 ImportErrorList

This read-only property keeps a list of problematic links in the input data source, found during import process. Content of the list is also written to the report 28.

Type: TImportErrorList 146

2.1.15 LinkCount

This read-only property returns the total number of links after calling execute 28.

Type: Integer

2.1.16 MaxDegree

This read-only property returns the maximum degree of the network after calling execute 28.

Type: Integer

2.1.17 MaxNodesPerCell

This property can be used to define how detailed the spatial index should be. Set the value before importing.

A higher value decreases the size of of the file and memory foot print, but reduces speed of spatial searches.

Default value is 50. Minimum value is 25.

Type: Integer

2.1.18 MBR

This read-only property reports the minimum bounding rectangle (MBR) after import

Type: TFloatRect 157

2.1.19 NodeCount

This read-only property returns the total number of nodes generated after calling execute 28.

Type: Integer

2.1.20 OnImportLink

In class TCustomImport assign this event to read custom data:

Parameters:
1) Link is automatically increased by one every time.
2) Vertices: This is a list of vertices (coordinates).
3) VertexCount: Indicates the number of vertices on the list. The list may be longer than actual number of elements.
4) Zfrom, Zto: Z-levels 16 for the link.
5) LastLink: Set this to true, when you have reached the last link to be read.

All links will be traversed twice. Depending upon your source of data, it may be faster to extract to a MIF file first.

Syntax: OnImportLink(link: integer; var vertices: TFloatPointArray 157; var vertexcount: TVertexCount 162; var Zfrom, Zto: integer; var LastLink: boolean)

2.1.21 PRJ

This string gets updated during the import process, if a PRJ file exists along with a SHP file and no coordinate unit has been specified.

Type: String

2.1.22 SkipSpatialIndex

This property allows you to skip creation of the spatial index during import to save time and disk space.

Spatial index is needed by TSpatialSearch 73.

The spatial index can not be created later on, unless you re-import the data.

Default: false

Type: Boolean

2.1.23 Starttime

This read-only property reports when importing started.

Type: TDatetime

2.1.24 Stoptime

This read-only property reports when importing stopped.

Type: TDatetime

2.1.25 TotalLength

This read-only property returns the total length for all links after calling execute 28.

Type: Double

2.1.26 ZFromField & ZToField

These 2 properties are used for describing Z-level 16 in input data.

The 2 properties refer to the field ID in the same way as it is being done in class TImportAttributes 31: First field has index 0.

For TAB files, the execute command will automatically look for .DAT files.
For MIF files, the execute command will automatically look for .MID files.
For SHP files, the execute command will automatically look for .DBF files.

Set both values >=0 to apply.

Default: -1

Type: Integer

2.2 TImportAttributes

This class is for importing attribute information for the links in the network.

	File-based	Event-based
Attributes	ExecuteAttribute 33	ExecuteAttributeEvent 33
External ID's (integers)	ExecuteExternalidInt 33	ExecuteExternalidIntEvent 33
External ID's (strings)	ExecuteExternalidString 33	ExecuteExternalidStringEvent 34
Limits	ExecuteLimit 34	ExecuteLimitEvent 34
Road names	ExecuteRoadname 34	ExecuteRoadnameEvent 35

Before calling any of the file-based methods above, call function Add 31 to add a list of files to import from. Supported file formats include DBF, DAT, MIF and CSV.

If you rather want to import using events, use one of these procedures mentioned in the column with event-based methods.

2.2.1 Add

Call this method to add a single file to the list of files for processing by one of the execute methods.

You can add DBF, DAT, MID and CSV files, but not mix different file types.

If you use CSV files, remember to set CodePageCSV 32. Codepage for other file types gets auto-detected: DAT files from their TAB counterpart and MID files from their MIF counterpart. DBF gets detected from the internal header.

Syntax: Add(filename: string)

In RW Net Standard you can only add 1 file in total. If you add another one, the previous one gets removed from the list.

2.2.2 AddFiles

This method can be used to add 31 multiple files at a time.

Syntax: AddFiles(files: TStringList 151)

Only available in RW Net Pro.

2.2.3 Cancelled

You can check this read-only property after calling one of the execute functions, except for the event based ones.
If true, the user stopped the process.

Type: boolean

2.2.4 Clear

This method will clear the list of files.

2.2.5 CodepageCSV

When reading from CSV files, set this property to the codepage used.

Default: Codepage of the local system.

Type: TCodePage 155

2.2.6 CodepageDBF

When reading from DBF/DAT files, set this property to the codepage used. Normally leaving it to 0 is sufficient, but DBF files from OpenStreetMap uses UTF-8, which isn't supported natively by DBF format. In that case set it to 65001.

If set to 0, it uses the codepage byte inside the file header. If that byte is 0 too, it uses the codepage of the local system.

Default: 0.

Type: TCodePage 155

2.2.7 Directory

This property points to where the output files are stored.

Default: Current directory.

Type: String

2.2.8 EncryptionKey

You can set this property if the imported files should be encrypted to prevent other users from using the files. Encrypting makes it harder, but can't fully prevent the very determined and skilled user from getting to your data.

Default value is 0 (no encryption).

Type: Int64

Only available in RW Net Pro.

2.2.9 ExecuteAttribute

Call this procedure to import attribute information from one or more files.

Specify fieldindex (0-based) or fieldname for fk = fkDBF. If fieldname is specified, it takes precedence.

Syntax: ExecuteAttribute(fieldindex: integer; fieldname: string; fk: TFileKind 157)

2.2.10 ExecuteAttributeEvent

Assign event OnReadAttribute for importing attributes. When the last record has been reached, set lastrecord = true.

TAttributeReadEvent = procedure(Sender: TObject; link: integer; var attribute: word; var lastrecord: boolean);

Syntax: ExecuteAttributeEvent

2.2.11 ExecuteExternalIDInt

Call this procedure to import external ID information from one or more files, when the field is an integer field.

If the value read doesn't fit into an integer 154, specify useint64 = true and an int64 154 will be used instead.

Int64 formatted files can only be opened with RW Net 4.18 or newer.

Specify fieldindex (0-based) or fieldname for fk = fkDBF. If fieldname is specified, it takes precedence.

Syntax: ExecuteExternalidInt(fieldindex: integer; fieldname: string; fk: TFileKind 157; useint64: boolean)

2.2.12 ExecuteExternalIDIntEvent

Assign event OnReadExternalIDInt for importing external ID's that are integer based. When the last record has been reached, set lastrecord = true.

Specify useint64 = true and int64 154 will be used for storage instead of integers 154, allowing much bigger numbers.

TExternalIDReadIntEvent = procedure(Sender: TObject; link: integer; var externalID: int64; var lastrecord: boolean)

Syntax: ExecuteExternalIDIntEvent(useint64: boolean)

2.2.13 ExecuteExternalIDString

Call this procedure to import external ID information from one or more files, when the field is a string field.

Specify fieldindex (0-based) or fieldname for fk = fkDBF. If fieldname is specified, it takes precedence.

Syntax: ExecuteExternalidString(fieldindex: integer; fieldname: string; fk: TFileKind 157)

2.2.14 ExecuteExternalIDStringEvent

Assign event OnReadExternalIDString for importing external ID's that doesn't fit in an integer. When the last record has been reached, set lastrecord = true.

TExternalIDReadStringEvent = procedure(Sender: TObject; link: integer; var exteralnID: string; var lastrecord: boolean)

Specify the maximum width of the strings to be read.

Syntax: ExecuteExternalidStringEvent(width: integer)

2.2.15 ExecuteLimit

Call this procedure to import limit information from one or more files.

Specify fieldindex (0-based) or fieldname for fk = fkDBF. If fieldname is specified, it takes precedence.

For DBF format only:
Constant and factor are optional parameters with default values 0 and 1. If applied, the limit is calculated like this:
(value - constant) * factor

This allows you to directly read from a field which doesn't fit the 0..255 range, but recalculate on the fly.
If the calculated value is outside the range, you get an exception.

Syntax: ExecuteLimit(fieldindex: integer; fieldname: string; fk: TFileKind 157; constant, factor: double)

See also LimitFileIndex 35

2.2.16 ExecuteLimitEvent

Assign event OnReadLimit for importing limits. When the last record has been reached, set lastrecord = true.

TLimitReadEvent = procedure(Sender: TObject; link: integer; var Limit: byte; var lastrecord: boolean)

Syntax: ExecuteLimitEvent

2.2.17 ExecuteRoadname

Call this procedure to import road names from one or more files.

Specify fieldindex (0-based) or fieldname. If fieldname is specified, it takes precedence.
If reading from MID file, it will automatically lookup the codepage from the MIF file.

Syntax: ExecuteRoadname(fieldindex: integer; fieldname: string; fk: TFileKind 157)

2.2.18 ExecuteRoadnameEvent

Assign event OnReadRoadname for importing road names. When the last record has been reached, set lastrecord = true.

TRoadNameReadEvent = procedure(Sender: TObject; link: integer; var name: string; var lastrecord: boolean)

All links will be traversed twice. Depending upon your source of data, it may be faster to extract to a CSV file first.

Syntax: ExecuteRoadnameEvent

2.2.19 LimitFileIndex

When calling ExecuteLimit 34 or ExecuteLimitEvent 34 this property is used in the naming of the output file.

Allowed interval is 1 to 9.

Default: 1

Type: integer

2.2.20 RoadNameFileIndex

When calling ExecuteRoadname 34 or ExecuteRoadnameEvent 35 this property is used in the naming of the output file.

Allowed interval is 1 to 99.

Default: 1

Type: integer

2.3 TImportSQL

This class can be used to import directly from a GIS enabled database.
MS SQL Server, Oracle and PostgreSQL ("PostGIS") all offers storage of gis data, directly inside the database.

We have implemented it for all three and for:
- .NET
- 32/64 bit DLL
- Delphi XE7 - XE8 - 10 - 10.1 - 10.2 - 10.3 - 10.4 - 11.0.

You can reuse the majority of the shared properties from TImport 26 with this class (CreateReport 28, NodeCount 29 etc.).

This class is available with Pro only.

For .NET you need:

- GeoPackage: Microsoft.Data.Sqlite
- MS SQL: Microsoft.Data.SqlClient

- Oracle: Oracle.ManagedDataAccess.dll or Oracle.ManagedDataAccess.Core
- PostgreSQL: Npgsql.dll and npgsql.nettopologysuite

For the MapBasic DLL version it is all compiled into the DLL.

For the VCL version you need to have UniDAC Pro installed too (version 6.4.15+ is required).

Performance

Example of importing the same dataset (Brazil, 6.5 million links), from different data sources:

		.NET	UniDAC (VCL)
TAB file	local	305	163 sec
GeoPackage	local	202	201 sec
MS SQL Server 2008 R2 Express	remote	275	194 sec
PostgreSQL 9.4	remote	391	329 sec
Oracle 11.2 XE	remote	1536	1422 sec

Full setup: Geography, Z-levels, attribute, road name, limit and external ID.

2.3.1 ExecuteGeoPackage

A GeoPackage is a geographically enabled SQLite database file.

You can import from it, using this method:

Syntax: ExecuteGeoPackage(filename, TableName: string; geography: boolean; attribute, roadname, externalid, limit, ZFrom, ZTo: string);

2.3.2 ExecuteMSSQL

This is the main method and is a single call to do all the processing.

The first 5 parameters always need to be set.
For the rest at least one need to be set. This way you can create just the attribute.bin file or similar if you have the rest in advance.

If geography is true, the field with the geography is automatically detected. For the remaining the fieldname need to be set.
Object types in the table can be LineString, while MultiLineString are skipped.

Do not specify the schema, it will automatically look up the schema on its own.

It will also automatically look for a MapInfo mapcatalog with additional meta information.

Example set of parameters for a table "roads" that has been uploaded to a local MS SQL Server Express database.

Parameter	Value
Server	"127.0.0.1\SQLEXPRESS" or "127.0.0.1" or "127.0.0.1:12345"
Database	"GIS1"

Username	"GIS_user1"
Password	"secret_code"
Tablename	"roads"
Geography	true
Attribute	"attribute4"
Roadname	"streetname"
Externalid	"ID"
Limit	""
ZFrom	"ZFromLevel"
ZTo	"ZToLevel"

Syntax: ExecuteMSSQL(Server, Database, Username, Password, TableName: string; geography: boolean; attribute, roadname, externalid, limit, ZFrom, ZTo: string);

2.3.3 ExecuteMSSQL2

This is the same method as ExecuteMSSQL 36, except it replaces these parameters: server, database, username, password,

with a connection string.

You are responsible for formatting it according to the database specifications.

2.3.4 ExecuteORACLE

This method is similar to the one for MSSQL 36.

2.3.5 ExecuteORACLE2

This is the same method as ExecuteORACLE 37, except it replaces these parameters: server, database, username, password,

with a connection string.

You are responsible for formatting it according to the database specifications.

2.3.6 ExecutePOSTGIS

This method is similar to the one for MSSQL 36.

2.3.7 ExecutePOSTGIS2

This is the same method as ExecutePOSTGIS 37, except it replaces these parameters: server, database, username, password,

with a connection string.

You are responsible for formatting it according to the database specifications.

2.3.8 LimitFileIndex

When calling ExecuteMSSQL 36 this property is used in the naming of the output file.

Allowed interval is 1 to 9.

Default: 1

Type: integer

2.3.9 RoadNameFileIndex

When calling ExecuteMSSQL 36 this property is used in the naming of the output file.

Allowed interval is 1 to 99.

Default: 1

Type: integer

2.3.10 WhereClause

This string allows you to restrict the import according to any SQL where-clause.
This is passed directly on to the engine.

Example "roadclass < 5"

Default: empty

Type: string

2.4 TNetwork

This is the main class that holds all the information about the street network, while the other classes (TSpatialSearch 73, TRouteCalc 101, TCalc 78) link to this, when doing calculations. Whatever you define here, is shared by all the other classes linking to it.

Besides holding the core network (geometry, topology, spatial index), it also allows you to work with other types of information: Attributes, time / speed, cost, road names, turn restrictions, limits etc.

This is a list of available methods / grouped by area: (*) = Pro only.

Basic opening & closing of the network

Directory 48
EncryptionKey 49
LinkLimit 55
Open 58
Close 45
CloseExternalID 46

Geometry & topology

These are generally fairly simple lookup functions returning information requiring little processing.

CoordinateUnit 46

Attributes

See this introductory chapter on attributes 5

Time

Time is defined as minutes and is the criteria for routing in fastest 93 mode

Speed

Internally speed is always stored as time for each link, so if you change one, you also change the other.

Cost

Use cost, when you want a more flexible routing criteria than just time or distance.

Turn restrictions

See this introductory chapter on turn restrictions 9.

Road Names

These are mostly used when creating driving directions.

External ID

See this introductory chapter on external ID 8.

Limits

See this introductory chapter on limits 8.

OpenLimit 59
GetLimit 53
SetLimit 62
SaveLimit 61

TRoute methods

Methods operating on a TRoute 161 instance (output from route calculation).

GetGISSectionRoute 53
RouteLength 61
NoDriveThroughCheck 57

Check functions

These are functions for verifying input. They are used internally by most of the other methods, so you generally don't need to call them on your own.

CheckCoordinate 44
CheckExternOpen 44
CheckLink 44
CheckLocation 44
CheckLocationList 45
CheckNode 45
CheckNodeList 45
CheckOpen 45
CheckTurnIndex 45

Export

Methods for exporting data to a GIS file, so you can view the actual data.

ExportLinks 49
ExportLinksFullSplit 49
ExportLocationList 50
ExportNodeList 50
ExportNodes 50
ExportPolyGeneration 50
ExportTrafficList 71 (*)
TurnExportGIS 66

Advanced methods

These are more complex methods doing various sorts of calculations / analysis.

Direction 47
DistanceBetweenNodes 48
DistanceBetweenPoints 48
DistanceToLink 48
DistanceToLinkSimple 48
DistanceToNode 48
DownStream 70 (*)
ExternalNodeId2ZLevels 51

FindDuplicateLinks 52
Join 71 (*)
Matrix 56
MatrixDyn 56
MatrixDyn2 56
ObjectCheck 58
ParallelLinks 59
Select 62
Split 63
Trace 72 (*)
UpdateAlphas 69
UpStream 73 (*)

GIS output

These 5 properties all define various settings, used when generating GIS output. See TGISwrite 122 class.
They are automatically populated when the network is opened.

Codepage 46
CompactMIF 46
CoordSys 46
EPSG 49
PRJ 60

When calling GISoutputInit 54 it also inherits these values.

GISarray 54 is for storing output, when you have chosen array as output format.

Random places

When you just need some random input data for testing.

RandomPoint 60
RandomNode 60
RandomLocation 60

2.4.1 AllowNegativeCost

If you set this to true, it allows you to work with negative costs under certain circumstances. See SetCost 62.

Default value: False

Property: boolean;

2.4.2 AttributeGet

This function returns the attribute 5 for the link.

Syntax: AttributeGet(link: integer): word

2.4.3 AttributeGetBit

This function returns the attribute 5 value for a single bit of the link.

Syntax: AttributeGetBit(link: integer; bit: byte): boolean

Example: AttributeGetBit(145,11) returns true if link 145 has been marked as a round-about link (bit 11).

2.4.4 AttributeSave

If you have made changes to the attributes, you can save the whole content as a new attribute.bin file. It will use the folder as specified by Directory 48 and overwrite an existing file.

Syntax: AttributeSave

2.4.5 AttributeSet

This method will change the whole attribute 5 of a link.

Syntax: AttributeSet(link: integer; value: word)

2.4.6 AttributeSetBit

This method will change an attribute 5 bit of a single link. Bit is a value from 0 to 15.

Syntax: AttributeSetBit(link: integer; bit: byte; value: boolean)

2.4.7 AttributeSetBits

This method will change an attribute 5 bit for all links, according to BA. Bit is a value from 0 to 15.

BA should have one more elements than LinkCount 55, since Links are 1-based and TBitArray 148 is 0-based.

Syntax: AttributeSetBits(bit: byte; BA: TBitArray 148)

2.4.8 AttributeSetSkipInSearchBit

This method will set the SkipInSearch bit for all closed links (both oneway bits set). For open links, the bit is cleared.

Syntax: AttributeSetSkipInSearchBit

2.4.9 CalculateCost

This will update a Cost array index as a linear combination of length and time:

Cost(,costindex) = weightlength * Length(*) + weighttime * Time(*, timeindex)*

Syntax: CalculateCost(costindex: integer; weightlength, weighttime: TCost; timeindex: integer; maxspeed: TCost)

Call CreateArrayCost 47 in advance to allocate the index.

Timeindex points to one of the arrays defined through CreateArrayTime[47]. If weighttime = 0, value of timeindex is ignored.

If both weights are <> 0, we recommend setting weighttime = 1. This ensures the values can be interpreted as time easily and be used together with turn delays if needed.

If maxspeed is defined, then time is adjusted according to that.

2.4.10 CalculateTime

This will calculate time on all links, by looking up the speed in the RCS array, based upon the road class attribute[5]:

Time(,index) = Length(*) / RCS(attribute(*)) * 60*

Call CreateArrayTime[47] in advance to allocate the index.

See also TCalc.MaxSpeed[89].

Syntax: CalculateTime(index: integer; RCS: TRoadClassSpeed[150])

2.4.11 CheckCoordinate

This will check if a coordinate is valid.

If using degrees / radians / grads there are natural limits for valid values (-180 to 180, -90 to 90 etc).

For all coordinate units the coordinatewindow[46] is used for checking that P is within a certain bounding box of the street network.
By setting CoordinateWindow < 0, this part of check is disabled.

Syntax: CheckCoordinate(P: TFloatPoint[157])

2.4.12 CheckExternalOpen

This method checks if the external ID[8] has been opened through Open[58].

Syntax: CheckExternalOpen

2.4.13 CheckLink

This will check if a link number is valid, i.e between 1 and LinkCount[55]. At the same time LinkLength[55] has be <> 0.

Syntax: CheckLink(link: Integer)

2.4.14 CheckLocation

This will check if a location number is valid, i.e link is between 1 and LinkCount[55] and percent is between 0 and 1.

Syntax: CheckLocation(loc: TLocation[158])

2.4.15 CheckLocationList

Checks 44 all elements in LL:

Syntax: CheckLocationList(LL: TLocationList 147)

2.4.16 CheckNode

This will check if a node number is valid, i.e between 1 and NodeCount 57.

Syntax: CheckNode(node: Integer)

2.4.17 CheckNodeList

Checks 45 all elements in NL:

Syntax: CheckNodeList(NL: TIntegerList 147)

2.4.18 CheckOpen

This method checks if the network has been opened through Open 58.

Syntax: CheckOpen

2.4.19 CheckTurnIndex

This checks if index is valid for referencing sets of Turn restrictions. See CreateArrayTurn 47.

Syntax: CheckTurnIndex(index: integer)

2.4.20 Clone

This method clones an existing network in memory. This is faster than opening the same network twice, but for different purposes.

Example:
```
NW:= TNetwork.create;
NW.open(....);
NW2:= TNetwork.create;
NW.clone(NW2);
```

It clones all elements, including limits, roadnames etc.

Syntax: Clone(NW: TNetwork);

2.4.21 Close

This method closes the network and releases all memory related to it. This includes arrays setup using CreateArray* functions, all roadname files etc.

Syntax: Close

2.4.22 CloseExternalID

This method closes the memory related to the external ID.
This can be used after loading turn restrictions and you don't need it anymore.
Saves a lot of RAM on large networks.

Syntax: CloseExternalID

2.4.23 CloseRoadNameFile

This method closes a single roadname file and releases the memory related to it.

Syntax: CloseRoadNameFile(FileNumber: integer)

2.4.24 Codepage

For defining the desired codepage when calling GISoutputInit 54.

When outputttting to TAB format, the codepage is automatically translated to a corresponding characterset such as WindowsLatin1 etc.

Property Codepage: TCodePage 155

2.4.25 CompactMIF

Property CompactMIF 126: boolean

2.4.26 CoordinateUnit

Read-only property. Is set when calling Open 58.

Type: TCoordinateUnit 155

2.4.27 CoordinateWindow

This property controls checking of coordinates 44 when entered into functions that accept coordinates.

It is used in checking if coordinates are within the Minimum Bounding Rectangle 57 + X % of the street network. This will prevent situations where you by mistake swap x and y coordinate or use lat/long coordinates when the street network was in a projected coordinate system or vice versa.

Use a negative number to skip checking.

An example: If the coordinate should be between 0 and 50 and CoordinateWindow = 20 (default), then only coordinates between -10 and 60 will be accepted.

Type: double

2.4.28 CoordSys

This property is set when calling Open 58.

Property CoordSys: string

2.4.29 CreateArrayCost

Call this method to allocate room for n cost arrays. Cost arrays can be used, when you want to a route that isn't shortest or fastest, but rather some other expression.

Syntax: CreateArrayCost(n: integer)

2.4.30 CreateArrayTime

Call this method to allocate room for n time arrays. Time arrays are primarily used for fastest path routing. Multiple arrays can be setup for different uses (vehicle types, time of day etc).

Default value is 60 km/h.

Syntax: CreateArrayTime(n: integer)

2.4.31 CreateArrayTurn

Call this method to allocate room for n turn arrays. Each array is a list of turn restrictions / turn delays.

When calling Open 58, this is automatically initialized for 1 array, so normally it isn't needed to call at all.

Syntax: CreateArrayTurn(n: integer)

2.4.32 CulDeSac

This read-only property returns true if a link is part of a Cul-De-Sac / dead end link. See also NonCulDeSacNodes 58.

A link is defined as a cul-de-sac, if you can't get back without making a U-turn.
If you can get back without making a U-turn, but only using the same link, it is a bridge 106.

Syntax: CulDeSac[Index: Integer]: boolean

2.4.33 Degree

This method returns the degree of a node. See network terminology 4 for details.

To iterate through the links connected to a node, use function Node2Link 72.

Syntax: Degree(node: integer): integer

2.4.34 Direction

Returns the turning angle (0-359) at node2 when moving from link1 to link2 via node2. This is based on the exact coordinates of the polylines and the node.

Link1 and link2 must both be connected to node2. Specifying node2 may seem superfluous, but is required since link1 and link2 could be parallel links.

Straight on is 0, to the left is 90, backward is 180 and to the right is 270.

Syntax: Direction(link1,node,link2: integer): integer

2.4.35 Directory

This property defines the location of all binary files used by RW Net. Default directory is the current path.

Type: string

2.4.36 DistanceBetweenNodes

Calculates the as-the-crow-flies distance between two nodes.

Syntax: DistanceBetweenNodes(node1,node2: integer): double

2.4.37 DistanceBetweenPoints

Calculates the as-the-crow-flies distance between P1 and P2.

Syntax: DistanceBetweenPoints(P1,P2: TFloatPoint 157): double

2.4.38 DistanceToLink

This method calculates the distance from P to link.

It returns this information:

- Percentage along the link (0 .. 1)
- Side of the link (-1: Left or 1: Right)
- Distance
- Coordinates of location on link

Syntax: DistanceToLink(P: TFloatPoint 157; link: integer; out percent: double; out side: integer; out distance: double; out Pnew: TFloatPoint 157)

See also DistanceToLinkSimple 48 and NearestLocation 75.

2.4.39 DistanceToLinkSimple

This method calculates the distance from P to link.

Syntax: DistanceToLinkSimple(P: TFloatPoint 157; link: integer): double

See also DistanceToLink 48 and NearestLocationSimple 76.

2.4.40 DistanceToNode

This method calculates the distance from P to a node.

Syntax: DistanceToNode(P: TFloatPoint 157; node: integer): double

2.4.41 DuplicateLink

This property can be used to check which link is a links duplicate.

Call FindDuplicateLinks 52 first.

If the link hasn't a duplicate, it returns 0.

Property DuplicateLink[Index: Integer]: integer

2.4.42 EncryptionKey

Set this property before calling Open 58, if your data are encrypted.

Type: int64

2.4.43 EPSG

This property is set when calling Open 58.

property EPSG: integer

2.4.44 ExportLinks

This method will export the currently open network, including external ID, limit and roadname information where available.

LL can be used if you want to split some of the links. Typically setup LL using FindOverPasses 74 or SplitAndSnap 78.
If you prepare LL on your own, remember to call these 2 methods after filling in the list: RemoveDuplicates and RemoveStartEndPos.

BA can be used to specify a selection - a subset of the links.

JoinNodes can be used to state groups of nodes, which should be merged into a single point during output.
The coordinates of the new point is the simple average of the points in the groups.
See output from JoinNodes 75 method.

LL, BA and JoinNodes can all be nil.

Syntax: ExportLinks(filename: string; GF: TGISformat 157; LL: TLocationList 147; BA: TBitArray 148; JoinNodes: TIntegerLists 147);

2.4.45 ExportLinksFullSplit

This method will export the currently open network, including external ID, limit and roadname information where available.

All links are split into short sections, between vertices. See map here: network terminology 4 (blue dots). The method is good for preparing OpenStreetMap data for use in RW Net. Use method Join 71 with topology=2 on the exported dataset and possibly also FindOverPasses 74 function.

BA can be used to specify a selection - a subset of the links. BA can be nil.

Syntax: ExportLinksFullSplit(filename: string; GF: TGISformat 157; BA: TBitArray 148)

2.4.46 ExportLocationList

This method will export LL, so it can be viewed externally. As a minimum the coordinate part of the items need to be filled in.
Use Location2CoordinateList 56 for this, if only the location is filled in.

Syntax: ExportLocationList(filename: string; GF: TGISformat 157; LL: TLocationList 147)

2.4.47 ExportNodeList

This method will export NL, so it can be viewed externally.

Syntax: ExportNodeList(filename: string; GF: TGISformat 157; NL: TIntegerList 147)

2.4.48 ExportNodes

This method will export the nodes of the currently open network. Nodes are styled according to the degree (MIF, TAB format only):

1: Big red dot
2: Little black dot
3: Medium blue dot
4+: Medium magenta dot.

Syntax: ExportNodes(filename: string; GF: TGISformat 157)

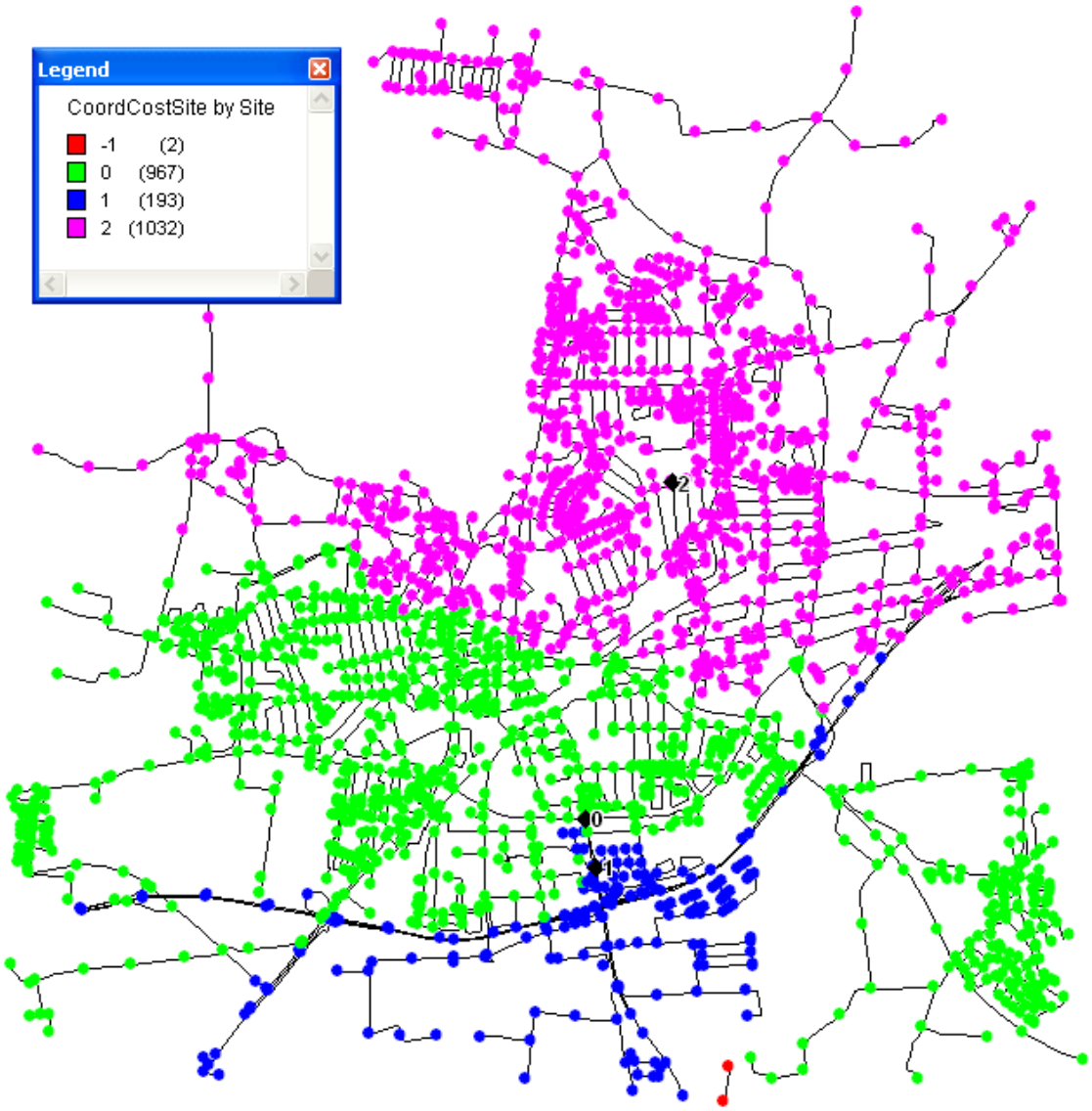
2.4.49 ExportPolyGeneration

This function is mostly for debugging purposes. It allows you to export the content of PG to 2 GIS files, so both facilities (startpoints) and the main data (CoordCostSiteList) are shown. Files called StartPoints and CoordCostSite are generated as specified in the same folder as the main network files.

Syntax: ExportPolyGeneration(filename: string; GF: TGISformat 157; PG: TPolyGeneration 149)

Example: ExportPolyGeneration("test", gfSHP, PG) will generate files test_startpoints.shp and test_coordcostsite.shp.

Example with 3 start points and thematic map of nearest facility:



2.4.50 ExternalID2Link

This method translates an external ID into the internal ID.

Syntax: ExternalID2Link(id: string): integer

2.4.51 ExternalNodeId2ZLevels

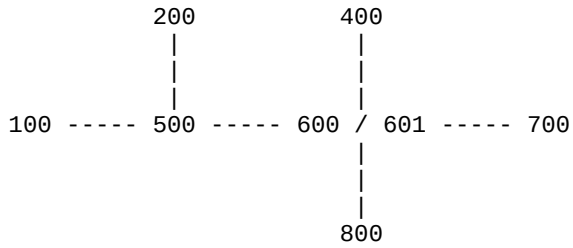
In most datasets Z-levels are used to describe when streets intersect at different levels such as with bridges.

However, some use external node numbers instead to indicate that a shared coordinate belongs at different levels.

In this example we have 6 links with these fromnode and tonode values:
1: 100 - 500
2: 200 - 500
3: 400 - 601
4: 500 - 600

5: 600 - 700
6: 601 - 800

As can be seen on the simplified map below, node 600 and 601 is really the same coordinate, but since the external node is different, they have different Z-levels.



This method helps you translating from external node numbers to Z-levels for the links.

After you have imported and opened a network, create a text file like this:
100,500
200,500
400,601
500,600
600,700
601,800

After calling the function you will get an output file with pairwise Z-levels like this:
0,0
0,0
0,1
0,2
2,0
1,0

Once applied to your dataset, you can import it again, this time declaring Z 31 during import.

Syntax: ExternalNodeId2ZLevels(InputFile, OutputFile: string; GF: TGISFormat 157);

2.4.52 ExtractSection

This method can be used to extract a part of a whole link. Start calling GetGISSection 53

Start and stop should be from 0 to 1 and if stop<start the order of the coordinates is swapped.

Example: ExtractSection(list,1,0) will return the whole list in reverse order.

Syntax: ExtractSection(list: TFloatPointArrayEx 157; start,stop: TPercent 160): TFloatPointArrayEx 157

2.4.53 FindDuplicateLinks

This method will find occurrences of 2 identical links, which are both marked as one-way streets, but in opposite directions.
They need to be digitized in the same direction.

You can use it to assign different cost to each direction of a link.

It is automatically called as part of Open 58 and OpenAttributes 59, but you can manually do it after updating one-way status.

The function returns the number of links found.

Use property DuplicateLink 49 to check the output.

Example: if DuplicateLink[4] = 7, then the other way around is also true: DuplicateLink[7] = 4.

TRouteCalc 101 and TDrivingDirections 110 uses this feature internally to check both directions of a street, before returning a result.

Syntax: FindDuplicateLinks: integer;

2.4.54 GeoJSON

When using gfGeoJSON 157 as output format in functions like ExportNodes 50 etc, this read-only property holds the output, if filename is empty.

Property GeoJSON: string

2.4.55 GetCost

This method returns cost for a single link and array index.

Syntax: GetCost(index,link: integer): TCost 156

See also CreateArrayCost 47, CalculateCost 43 and SetCost 62

2.4.56 GetGISSection

This method returns a list of coordinates for a link in the network.

Syntax: GetGISSection(link: integer): TFloatPointArrayEx 157

2.4.57 GetGISSectionRoute

This method returns a list of coordinates for a whole route.

Syntax: GetGISSectionRoute(route: TRoute 161): TFloatPointArrayEx 157

2.4.58 GetLimit

Returns limit (0-255) for the specified limit and link.
You need to have called OpenLimit 59 in advance to setup the memory.

Syntax: GetLimit(LimitID,link: integer): byte

2.4.59 GetLimitBit

Returns limit value (true/false) for the specified limit, link and bit (0-7).
You need to have called OpenLimit 59 in advance to setup the memory.
It is aimed at bitpatterns.

Syntax: GetLimitBit(LimitID,link: integer; bit: byte): boolean;

2.4.60 GetSpeed

Returns speed for the specified array index and link.

Syntax: GetSpeed(index,link: integer): TCost 156

2.4.61 GetTime

Returns time (minutes) for the specified array index and link.

Syntax: GetTime(index,link: integer): TCost 156

2.4.62 GISarray

When using gfArray 157 as output format in functions like ExportNodes 50 etc, this read-only property holds the output.

Property GISarray: TGISarray 129

2.4.63 GISoutputInit

This function can be used to create a TGISwriter object.
It will be created with the same codepage as specified here 46.

Please see Feature Matrix 2 for supported formats in your version.

Syntax: GISoutputInit(filename: string; GF: TGISformat 157): TGISwriter 122

2.4.64 Hierarchy

This array property can be used to get or set the hierarchy of a link. A hierarchy is a value from 1 to 5. See attributes 5.

If the hierarchy hasn't been set, it returns 0.

Property Hierarchy[Index: Integer]: integer

2.4.65 Length

This returns the length of the complete network.

Syntax: Length: TCost 156

2.4.66 Link2FromNode

Returns the number of the node at the start of the link. This is where digitizing has started.

Syntax: Link2FromNode(link: integer): integer

2.4.67 Link2ToNode

Returns the number of the node at the end of the link. This is where digitizing has ended.

Syntax: Link2ToNode(link: integer): integer

2.4.68 LinkCount

Return the highest link-number in the currently loaded network, which should equal to the number of links in the corresponding GIS-network.

Syntax: LinkCount: integer

2.4.69 LinkLength

This function returns the length of the link.

If the value is 0, it means the link isn't valid for routing. Please go back and check the result of the import process.

Syntax: LinkLength(link: integer): TCost 156

2.4.70 LinkLimit

Returns the maximum number of links according to your license. See feature matrix 2 (network size).

Syntax: LinkLimit: integer

2.4.71 Link2ExternalID

This method returns the external ID 8 from the internal ID.

Syntax: Link2ExternalID(link: integer): string

2.4.72 Link2RoadName

This method returns the roadname for a specific link and RoadFileID. The roadfile 59 should have been opened in advance.

Syntax: Link2RoadName(RoadFileID,link: integer): string

2.4.73 Link2RoadNameID

This method returns the roadnameID for a specific link and RoadFileID. The roadfile 59 should have been opened in advance.

A roadnameID is an integer, that corresponds to a roadname. It is more compact than a roadname and it is faster to do comparisons using roadnameID's.

RoadnameID's can be translated to road names this way 61.

Syntax: Link2RoadNameID(RoadFileID,link: integer): integer

2.4.74 Location2Coordinate

This method translates a location into a set of coordinates, with the ability to offset it to one of the sides of the link. When offset is positive, it will be on the right side of link, negative means left side. This is the same setup as DistanceToLink 48 uses for side.

Syntax: Location2Coordinate(loc: TLocation 158; offset: double): TFloatPoint 157

2.4.75 Location2CoordinateList

Same as Location2Coordinate 55, just for a whole list. LL is updated with the coordinates.

Syntax: Location2CoordinateList(LL: TLocationList 147; offset: double)

2.4.76 LoopLink

This function returns true if a link is a loop link.

Syntax: LoopLink(Index: Integer): boolean

2.4.77 LoopLinks

This function returns true if any link in the network is a loop.

Starting from 1-1-2012, networks with loop links will not work in TCalc 78, TRouteCalc 101 and TDrivingDirections 110.

Syntax: LoopLinks: boolean

2.4.78 Matrix

This method calculates a matrix of distances between all combinations of nodes in NL. Distance uses as-the-crow fly distances. If extra is true, the matrix will have an additional row and column, allowing for special optimization in class TTSP 139.

Syntax: Matrix(NL: TIntegerList 147; extra: boolean): TMatrix 159

2.4.79 MatrixDyn

This method calculates a matrix of distances between all combinations of locations in LL. Distance uses as-the-crow fly distances. If extra is true, the matrix will have an additional row and column, allowing for special optimization in class TTSP 139.

You should have called Location2CoordinateList 56 in advance.

Syntax: MatrixDyn(LL: TLocationList 147; extra: boolean): TMatrix 159

2.4.80 MatrixDyn2

This method calculates a matrix of distances between all combinations of locations in LL1 and LL2. Distance uses as-the-crow fly distances.

You should have called Location2CoordinateList 56 in advance.

Syntax: MatrixDyn2(LL1, LL2: TLocationList 147): TMatrix 159

2.4.81 MaxDegree

Returns the maximum degree in the network. This is typically 5-6.

Syntax: MaxDegree: integer

2.4.82 MBR

Returns the minimum bounding rectangle of the currently loaded network. Is set when calling Open 58.

Syntax: MBR: TFloatRect 157

2.4.83 Node2Coordinate

Returns the coordinates of a node.

Syntax: Node2Coordinate(node: Integer): TFloatPoint 157

2.4.84 NodeCount

Return the highest node-number in the currently loaded network. The import 26 process assigns node numbers automatically, this can not be controlled by the user.

Syntax: NodeCount: integer

2.4.85 NoDriveThroughCheck

This function checks if NoDriveThrough 91 bit is set for any link on the route and the logical area is different from that of the first and last link on the route.

Returns true if the route isn't valid.

Syntax: NoDriveThroughCheck(route: TRoute 161): boolean

2.4.86 NoDriveThroughInit

If you change the NoDriveThrough 5 bit for some of the links after loading the network, you should call this function again to have various internal datastructures reset.

Syntax: NoDriveThroughInit

2.4.87 NoDriveThroughSet

This function checks if NoDriveThrough 91 bit is set for any link in the network.

Syntax: NoDriveThroughSet: boolean

2.4.88 NonCulDeSacNodes

This function returns a list of all nodes, that are not completely surrounded by CulDeSac 47 links.

It can be used together with function Nearest 90 to move from a node in a CulDeSac area.

Syntax: NonCulDeSacNodes(NL: TIntegerList 147)

2.4.89 ObjectCheck

This method checks individual objects for issues. I.e. not definite errors, but just issues.

It looks for:
- Duplicate nodes
- Self-intersecting objects
- Objects with sharp turns (set turn_angle parameter to define threshold, 90 is a good value)

Returns the number of objects with issues.

Syntax: ObjectCheck(filename: string; GF: TGISformat 157; turn_angle: integer): integer

In standard version you are limited to networks with <10000 links.

2.4.90 OneWayGet

This method returns information about one-way status for a link.

0: No restrictions
512: Travel only allowed in the direction of digitization
1024: Travel only allowed in the opposite direction of digitization
1536: Closed

Syntax: OneWayGet(link: integer): word

2.4.91 OneWaySet

This method sets information about one-way status for a link.

0: No restrictions
512: Travel only allowed in the direction of digitization
1024: Travel only allowed in the opposite direction of digitization
1536: Closed

Syntax: OneWaySet(link: integer; value: word)

2.4.92 Open

This method opens a street network and loads all information into memory. Files are loaded from Directory 48 property.

If attributes is true, attribute.bin is also opened.

Set coord3cache to true, unless you have limited RAM.

Set spatialindex to true, if you want to load the spatial index and use TSpatialSearch 73 methods.

ExternalID parameter:
0: Do not open
1: Open, but no caching
2: Open, cache index
3: Open, cache index + keys

Syntax: Open(attributes, Coord3Cache, spatialindex: boolean; externalid: integer)

2.4.93 OpenAttributes

This method (re)opens the attributes file. Files are loaded from Directory 48 property.

Syntax: OpenAttributes()

2.4.94 OpenLimit

Use this method to open limit files. Filenumber should refer to the naming of the file, while LimitID is from 1 to 9. It is important to open them in sequence or the routing restrictions will not work. For instance open limitID 1 and 2, but not 4 or higher.

Syntax: OpenLimit(FileNumber, LimitID: integer; bitpattern: boolean)

See also Limits 8, LimitFileIndex 35, GetLimit 53, SetLimit 62 and TCalc.SetLimit 93.

2.4.95 OpenRoadName

This method opens a roadname 8 file, previously setup through import.

Specify the number of the file (1..99) and if it should be cached. It is only relevant to cache if you plan to generate MANY driving directions.

Syntax: OpenRoadName(RoadFileID: integer; cache: boolean)

2.4.96 ParallelLinks

Identifies group of links, which start and end at the same two nodes. These might give problems in some networking algorithms ("emme/2" for instance).

RW Net has no problem with parallel links, unless you want to apply a turn restrictions from one parallel link to another and only want it at one of the 2 nodes they have in common.

The function returns the number of parallel links found.

The generated GIS file contains fields for:
- Link: Original link ID
- Group: 1, 2, 3 ....
- SameLength: Logical value, which is true if all links in the group has the same length. This usually means the same link has been digitized twice.

Syntax: ParallelLinks(filename: string; GF: TGISformat 157): integer

In Standard version you are limited to networks with <10000 links.

2.4.97 PRJ

This property is set when calling Open 58.

property PRJ: string

2.4.98 RandomLocation

Returns a random location.

Syntax: RandomLocation(r: TRandom 149): TLocation 158;

2.4.99 RandomNode

Returns a random node.

Syntax: RandomNode(r: TRandom 149): integer;

2.4.100 RandomPoint

Returns a random point on the network.

It is a coordinate within 10 meters of a location.

Syntax: RandomPoint(r: TRandom 149): TFloatPoint 157;

2.4.101 ReadCost

This method allows you to read speed for all links from a single DAT or DBF file.

Specify the full filename, including path.
Fieldindex is 0-based.
If fieldname is defined, fieldindex is ignored.

If cost is 0 or negative for any link, it is ignored.

Syntax: ReadCost(index: integer; filename: string; fieldindex: integer; fieldname: string);

2.4.102 ReadSpeed

This method allows you to read speed for all links from a single DAT or DBF file.

Specify the full filename, including path.
Fieldindex is 0-based.
If fieldname is defined, fieldindex is ignored.
if mph=true, all speeds are assumed to be in mph and multiplied by 1.609 when read from the file.

If speed is 0 or negative for any link, it is ignored.

Syntax: ReadSpeed(index: integer; filename: string; fieldindex: integer; fieldname: string; mph: boolean);

2.4.103 ReadTime

This method allows you to read speed for all links from a single DAT or DBF file.

Specify the full filename, including path.
Fieldindex is 0-based.
If fieldname is defined, fieldindex is ignored.

If time is 0 or negative for any link, it is ignored.

Syntax: ReadTime(index: integer; filename: string; fieldindex: integer; fieldname: string);

2.4.104 RoadClass

This array property can be used to get or set the road class of a link. A road class is a value from 0 to 31. See attributes 5.

Property RoadClass[Index: Integer]: integer

2.4.105 RoadName2RoadNameID

This method translates a roadname into the corresponding roadname ID.

Syntax: RoadName2RoadNameID(RoadFileID: integer; roadname: string; ignorecase: boolean): integer

2.4.106 RoadNameID2RoadName

This method returns roadname for a roadname ID.

Syntax: RoadNameID2RoadName(RoadFileID,RoadNameID: integer): string

2.4.107 RoadNameMaxWidth

This method returns the maximum width for an open roadfile and for a specific codepage. This can be used when writing to a TGISwrite 122 output with fixed field width, such as DBF, SHP, MIF and TAB.

Syntax: RoadNameMaxWidth(RoadFileID: integer; Codepage: TCodePage): integer

2.4.108 RouteLength

This method returns the length of a route.

See also RouteCost 91 and RouteTime 92.

Syntax: RouteLength(Route: TRoute 161): TCost 156

2.4.109 SaveLimit

This method can save a limit file, either create it from scratch or replace an existing one after updates has been made.

Syntax: SaveLimit(FileNumber, LimitID: integer);

2.4.110 Select

This method can be used for selecting from the street network.

Output is stored in BA. New selections are set and added to any previous selections in BA.

Roadclass_min and roadclass_max specifies the interval for selections. Use 0 and 31 to ignore.

Hierarchy_min and hierarchy_max specifies the interval for selections. Use 0 and 5 to ignore.

You can specify a RoadFileID and RoadNameID to select a specific roadname. Use 0 to ignore.

For each of the bits 8 - 15 in the attribute 5 you can specify the value 0 or 1. Use 2 to ignore.

Syntax: Select(BA: TBitArray;
roadclass_min,roadclass_max,hierarchy_min,hierarchy_max: integer;
RoadFileID,RoadNameID: integer;
bit8,bit9,bit10,bit11,bit12,bit13,bit14,bit15: byte)

2.4.111 SelectLimit

This method can be used for selecting from the street network.

Output is stored in BA. New selections are set and added to any previous selections in BA.

It selects all links where LimitID is in the range limit_min to limit_max.

Syntax: SelectLimit(BA: TBitarray 148; LimitID: integer; limit_min,limit_max: byte);

2.4.112 SelectLinksWithLimits

This method can be used for selecting from the street network.

Output is stored in BA. New selections are set and added to any previous selections in BA.

It selects all links with a limit defined. If includeoneway is true, it will also select links where both oneway bits 5 are set (512 + 1024).

Syntax: SelectLinksWithLimits(BA: TBitArray 148; includeoneway: boolean);

2.4.113 SetCost

This method sets cost for a single link and array index.

Normally cost has to be a positive number, unless you set AllowNegativeCost 42.

Syntax: SetCost(index,link: integer; cost: TCost)

See also CreateArrayCost 47, CalculateCost 43, GetCost 53 and TCalc.SetCheapest 92.

2.4.114 SetLimit

This method sets limit for a single limitID and link.
You need to have called OpenLimit 59 in advance to setup the memory.

This doesn't change any file on disk.

Syntax: SetLimit(limitID,link: integer; value: byte)

2.4.115 SetLimitBit

This method sets the limit (true/false) for a single limitID, link and bit (0-7).
You need to have called OpenLimit 59 in advance to setup the memory.
It is aimed at bitpatterns.

This doesn't change any file on disk.

Syntax: SetLimit(limitID,link: integer; bit: byte; value: boolean)

2.4.116 SetSpeed

Sets speed for the specified array index and link. Internally it is the corresponding time, that is stored.

See also MaxSpeed 89.

Syntax: SetSpeed(index,link: integer; speed: TCost 156)

2.4.117 SetTime

Sets time (minutes) for the specified array index and link.

Syntax: SetTime(index,link: integer; time: TCost 156)

2.4.118 SkipLinks2BitArray

This procedure will copy bit 15 from the attribute 5 to a bitarray, for use in spatial searches.

Syntax: SkipLinks2BitArray(BA: TBitArray)

2.4.119 Split

This method will create entries in LL for all links in the network and for every x km.

Example: If the value of distance parameter is 1 km and a link is 3.6 km long, entries will be created like this:
Evenout = false: 1, 2 and 3 km (3 entries)
Evenout = true: 0.9, 1.8 and 2.7 km (3 entries)
No entries are created for links shorter than 1 km.

Call ExportLinks 49 afterwards to have the network saved, but with shorter links.

Syntax: Split(distance: TCost 156; evenout: boolean; LL: TLocationList 147)

2.4.120 SwapList

This method swaps the order of coordinates in the variable.

Syntax: SwapList(var list: TFloatPointArrayEx)

2.4.121 SwapOneWay

This method swaps all oneway restrictions, so they point in the opposite direction. If both oneway bits 5 (9 and 10) are set, nothing happens.

It can be used to calculate isochrones from many-to-one, by first swapping the restrictions, doing it one-to-many and then swapping back again.

This is for instance relevant, when doing a drivetime isochrone and it is more important how fast you can get TO the center (example: hospitals), rather than getting FROM the center (example: fire stations).

Call TurnSwap 69 too, if you have turn restrictions.

Syntax: SwapOneWay

2.4.122 TurnAutoProcess

This method allows to automatically detect turns and add turn delays through out your network.

You can either use the built-in rules for adding delays for T-junctions and normal junctions, or override these with events.

In any case, it should be specified if traffic is right- or left-hand. Left-hand is known from UK, Ireland, Australia, New Zealand, Japan, India, South Africa etc.

It should also be specified if any nodes should be skipped completely. This could be nodes / junctions which are part of ramps or use traffic lights, so you want to set up different rules.

We suggest calling TurnExportGIS 66 once you have called TurnAutoProcess to see what it actually gives in minutes.

This method is quite slow for large networks, so use it with care.

Events

When using the events you will just get a list of links back, making up the intersection. This includes intersections or nodes with degree > 2.
The list is ordered in the same way as is shown on the small maps below.

T-junctions:
TTurnTEvent = procedure(Sender: TObject; node, link1, link2, link3: integer)

Normal junctions:
TTurnEvent = procedure(Sender: TObject; node: integer; links: TIntegerArray 158)

Built-in rules

Delays for each road class in the network is supplied as a TRoadClassTurnCost 150 object. For all links in each intersection the delay is then looked up, based upon their road class. If a turn involves crossing multiple traffic flows in the intersection, these are added together as can be seen here:

For a T-junction, where 1-2 is the main road:

```
1---+---2
```

```
     |
     3
```

Delays for right-hand traffic:

From 3 to 1: 1.5 * (delay1+delay2)
From 3 to 2: delay1
From 2 to 3: delay1
Other turns: No delay

Delays for left-hand traffic:

From 3 to 1: delay2
From 3 to 2: 1.5 * (delay2 + delay1)
From 1 to 3: delay2
Other turns: No delay

Main road is determined from geometry: The link combination closest to a straight line is the main road.

For a normal intersection, where 1-3 is the main road:

Left-hand traffic

```
     2
     |
1---+---3
     |
     4
```

Right-hand traffic

```
     4
     |
1---+---3
     |
     2
```

From 1 to 4: delay3
From 2 to 1: 1.5 * (delay1 + delay3 + delay4)
From 2 to 3: delay1
From 2 to 4: 1.5 * (delay1 + delay3)
From 3 to 2: delay1
From 4 to 1: delay3
From 4 to 2: 1.5*(delay1 + delay3)
From 4 to 3: 1.5*(delay1 + delay2 + delay3)
Other turns: No delay

Main road gets detected from the delays. Largest delay means main road.

If opposing roads, 1-3, can't be identified as the main road, the intersection is skipped. This happens if for instance 1-2 has the largest delay.

If the delay for all 4 roads is the same:

Delays for right-hand traffic:

Right turns: delay1

Straight ahead: 2 * delay1
Left turns: 4.5 * delay1

Delays for left-hand traffic:

Left turns: delay1
Straight ahead: 2 * delay1
Right turns: 4.5 * delay1

For intersections with >4 links:

No processing occurs. You can use the events instead.

Syntax: TurnAutoProcess(index: integer; LeftHandTraffic: boolean; RCTC: TRoadClassTurnCost 150; SkipNodes: TBitArray 148)

2.4.123 TurnClear

This method clears turn restrictions for the specified index.

Syntax: TurnClear(index: integer)

2.4.124 TurnCount

This method returns number of turn restrictions for the specified index.

Syntax: TurnCount(index: integer): integer;

2.4.125 TurnExportBin

This method saves all turn restrictions to a file on disk, which can later be loaded with function TurnImportBin 67.

Bin files always use link ID as references.

Specify a full filename, preferably with along this pattern "turn*.bin" (makes it easier to recognize the file).

Syntax: TurnExportBin(index: integer; filename: string)

2.4.126 TurnExportGIS

This method writes all turn restrictions to a TGISwrite, so it is easier to graphically view the turn restrictions.

Specify a full filename.

Syntax: TurnExportGIS(index: integer; filename: string; GF: TGISformat 157)

2.4.127 TurnExportTXT

This method saves all turn restrictions to a text file on disk, which can later be loaded with function TurnImportTXT 67. Internal link ID's are used in the output.

Specify a full filename.

Syntax: TurnExportTxt(index: integer; filename: string)

2.4.128 TurnExportTXT2

This method saves all turn restrictions to a text file on disk, which can later be loaded with function TurnImportTXT 67. External link ID's are used in the output.

Specify a full filename.

Syntax: TurnExportTxt2(index: integer; filename: string)

2.4.129 TurnImportBin

This method loads turn restrictions from a file on disk, created by TurnExportBin 66. It doesn't clear the list first.

Specify a full filename.

Syntax: TurnImportBin(index: integer; filename: string)

2.4.130 TurnImportTxt

This method loads turn restrictions from a text file on disk. Supply a full filename, including folder. It doesn't clear the list first.

The format is one or more lines, where each line stores one restriction with parameters stored in space separated format. Different types of restrictions are possible:

0: Simple Turn restriction, 2 external link ID's + 1 cost value
1: Simple Turn restriction 68, 2 link ID's + 1 cost value
2: TurnStandard 68, coordinates for node
3: Mandatory turn, 2 external link ID's
4: Mandatory turn 68, 2 link ID's
5: Complex Turn restriction, >2 external link ID's + 1 cost value
6: Complex Turn restriction 68, >2 link ID's + 1 cost value

File example:

```
// Comment
0 A4003234 A4003127 -1
1 456 230 -1
2 -77.024098 38.902711
3 A4003234 A4003127
4 456 230
5 A4003279 A4003234 A4003127 -1
6 89 456 230 -1
```

Lines starting with // are ignored as comments.

The ITN converter will create turn restriction files in this format.

If you use turn restrictions with external ID's (type 0, 3 and 5), make sure you have called Open 58 with externalID>0 or you will get an error code returned.

Type 0, 2, 3 and 4 gets translated into one or more type 1 during import and type 5 gets translated into type 6 during import.

The function returns the number of errors during the import. That can be due to external ID's not valid or non-existing turns.

Syntax: TurnImportTxt(index: integer; filename: string): integer;

2.4.131 TurnMandatory

This method defines that turns from link1 is only allowed if the next turn is link2.

Internally this is translated into a number of turn restrictions. These are only applied at the end of link1, where it is actually possible to connect to link2.

If link1 and link2 are parallel links, you will get an error.

Syntax: TurnMandatory(index: integer; link1,link2: integer)

2.4.132 TurnReset

Clears the list of turn restrictions.

Syntax: TurnReset(index: integer)

2.4.133 TurnRestriction

This method defines a restriction on turns from link1 to link2.

cost < 0: Turn prohibited
cost = 0: Remove turn restriction
cost > 0: Additional cost related to the turn (= delay).

If link1=link2 the restriction (a U-turn) is skipped. See here how to apply U-turn restrictions 96. It is not possible to have delays for U-turns, they can only be either allowed or banned.

If link1 and link2 are parallel links, a turn restriction is added at both nodes. Prevent this by breaking up one of the links.

Syntax: TurnRestriction(index,link1,link2: integer; cost: TCost 156)

2.4.134 TurnRestrictionComplex

This is the same method as TurnRestriction 68 except up to 6 links can be defined as making up the restriction. If you need more than 6 links, use TurnImportTXT 67 instead.

Syntax: TurnRestrictionComplex(index,link1,link2,link3,link4,link5,link6: integer; cost: TCost 156)

2.4.135 TurnStandard

Adds turn restriction on standard 4-degree intersection, which means no turns are allowed - only driving straight through. The method also works for nodes with higher, but still even degree.

Syntax: TurnStandard(index,node: integer)

2.4.136 TurnSwap

This method swaps the direction of all turn restrictions for the specified index.

Use it in combination with TNetwork.SwapOneWay 64, where you can read further details.

Syntax: TurnSwap(index: integer)

2.4.137 UpdateAlphas

Alpha is a parameter used internally by TRouteCalc 101 to direct routes faster towards the target.

After changing speed, time or cost and before calculating routes with TRouteCalc 101, you should call this method.

For shortest path routing with TRouteCalc, the method is not required.

Syntax: UpdateAlphas

2.4.138 ValidCodePage

This function returns a codepage which matches the currently loaded roadnames.
If possible it will return the default codepage for the system, otherwise it will look through the list of codepages and return the first match.

If TAB parameter is true, it returns a codepage valid for TAB/MIF output.
If TAB parameter is false, it returns a codepage valid for SHP/DBF output.

If the function returns 0, it didn't find any codepage matching all roadnames (possible, but not likely to happen).

Assign the value to CodePage 46 property.

Syntax: ValidCodePage(TAB: boolean): word;

List of codepages and matching charset name for TAB/MIF files:

1252, WindowsLatin1
1250, WindowsLatin2
1256, WindowsArabic
1251, WindowsCyrillic
1253, WindowsGreek
1255, WindowsHebrew
1254, WindowsTurkish
950, WindowsTradChinese
936, WindowsSimpChinese
932, WindowsJapanese
949, WindowsKorean
874, WindowsThai
1257, WindowsBalticRim
1258, WindowsVietnamese
437, CodePage437
850, CodePage850
852, CodePage852
857, CodePage857

860, CodePage860
861, CodePage861
863, CodePage863
865, CodePage865
855, CodePage855
864, CodePage864
869, CodePage869
28591, ISO8859_1
28592, ISO8859_2
28593, ISO8859_3
28594, ISO8859_4
28595, ISO8859_5
28596, ISO8859_6
28597, ISO8859_7
28598, ISO8859_8
28599, ISO8859_9

2.4.139 Write

These methods are for writing results from various calculations directly to a DBF or DAT file. DAT is part of a MapInfo TAB file and similar to a DBF file.

All 4 variations below allow you to write to gfDecimal, gfFloat, gfInteger, gfSmallInt and gfLogical fields.
In any case values are written so they best possibly are stored in the underlying field.

Values which are too big, makes it raise an error, such as storing 100000 in a SmallInt field (valid range -32767 to 32767).
If you try to store a number in a Logical field, all values >0 are treated as True.

Length of TIntegerArray, TCostArray and TBitArray need to match the number of records in the file.

TIntegerList is treated as a list of records marked as True. If you have reset=true at the same time, all other records are marked as false.

Fieldindex is 0-based. If you specify fieldname, it is used instead of fieldindex.

Syntax:
Write1(filename: string; fieldindex: integer; fieldname: string; value: TIntegerArray 158);
Write2(filename: string; fieldindex: integer; fieldname: string; value: TCostArray 156);
Write3(filename: string; fieldindex: integer; fieldname: string; value: TBitArray 148);
Write4(filename: string; fieldindex: integer; fieldname: string; value: TIntegerList 147; reset: boolean);

2.4.140 Pro Methods

2.4.140.1 DownStream

This method can be used for tracing in an oriented network. It will start from a link and trace in the forward (downstream) direction as long as there is only one directed link from the next node (unique direction for flow). Links without direction are ignored. You can use direction 512 / 1024 as in a normal street network.

This method is only useful for utility networks, such as sewers, water pipes etc. It has little relevance for street networks.

Output linklist is in the order of flow, starting with the input link.

Syntax: DownStream(link: integer; linklist: TIntegerList[147])

See also Trace[72] and UpStream[73]

2.4.140.2 ExportTrafficList

This method will export TL, so it can be viewed externally.

If lines = false:
Output is shown as point objects with origin / destination records shown as "O" and "D".

If lines = true:
Output is shown as lines connecting origin and destination.

Syntax: ExportTrafficList(filename: string; GF: TGISformat[157]; TL: TTrafficList[148]; lines: boolean)

2.4.140.3 Join

This will identify neighbouring links and join them in groups. The grouping can be defined by setting 3 parameters, where at least one of them need to be <> "ignore":

Topology
0: Ignore it
1: Connected
2: Intersection to intersection (intersection: Node with degree[47] >= 3)
3: Intersection to intersection, but ignoring cul-de-sac links

RoadFileID
0: Ignore roadname
N: Split when roadname changes

Attributes:
False: Ignore attributes
True: Split according to attributes

Result is stored in IA array: Indices with the same value belong to the same group.
Result can also be written to a TGISwrite output, if filename is specified. If GF = gfArray, just set filename to something.

Using parameter combination (0,0,false) is not allowed, since it would join ALL links into one large object.

When using topology=2, joins that would result in loops, are avoided.

Normally it used with these parameters, when the output is to be used for routing:
Topology = 2
RoadfileID >0, if the network is to be used with driving directions.
Attributes = true.

If turn restrictions are defined, they are exported to a file with ".turn" as extension with the updated link ID's as reference.

Syntax: Join(filename: string; GF: TGISformat[157]; topology,RoadFileID: integer; attributes: boolean; var IA: TIntegerArray[158])

2.4.140.4 Node2Link

This method returns the ID of the links connected to a node.

Iterate through the links this way:

```
for index = 1 to Degree(node)
  print node2link(node,index)
next
```

Syntax: Node2Link(node,linkindex: integer): integer

2.4.140.5 Trace

This method can be used for tracing in a network. It will start from a link and trace in all directions until a node is reached that is marked with True in the Valves input parameter.

Oneway restrictions are ignored.

This method is only useful for utility networks, such as sewers, water pipes etc. It has little relevance for street networks.

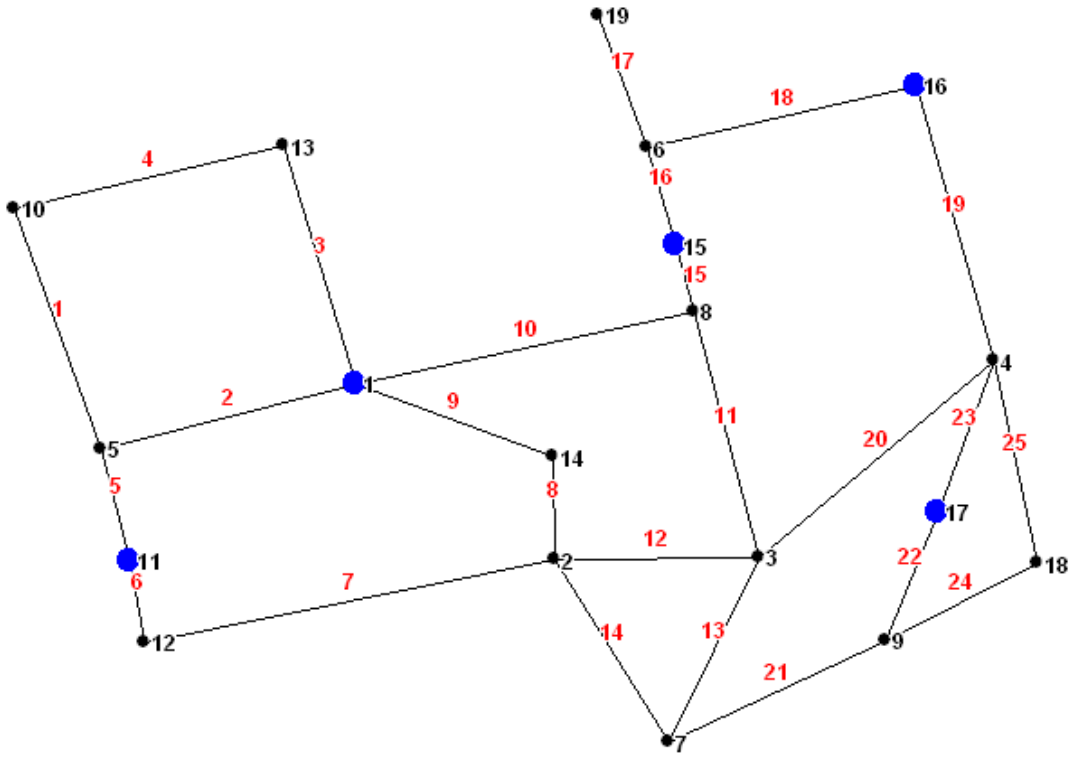
Output parameter ValvesReached shows which of the valves was reached.
Output parameter LinksReached shows which of the links was reached.

Syntax: Trace(link: integer; Valves, ValvesReached, LinksReached: TBitArray)

See also DownStream and UpStream

Example:
Input:
Start link: 1 (red labels)
Valves: 1, 11, 15, 16, 17 (blue dots)

Output:
ValvesReached: 1, 11
LinksReached: 1, 2, 3, 4, 5.



2.4.140.6 UpStream

This method can be used for tracing in an oriented network. It will start from a link and trace in the reverse (upstream) direction, branching if required. Links without direction are ignored. You can use direction 512 / 1024 as in a normal street network.

This method is only useful for utility networks, such as sewers, water pipes etc. It has little relevance for street networks.

Upstream links are marked as true in the output, including the input link.

Syntax: UpStream(link: integer; links: TBitArray 148)

See also DownStream 70 and Trace 72

2.5 TSpatialSearch

This class is for making spatial searches in the network. Generally as either searching for nodes or links (locations).

On top of this, various topological checks can also be performed: FindNonConnected 74, FindOverPasses 74 and Split 78.

When opening the network 58, make sure parameter "spatialindex" is true.

2.5.1 Create

When creating an instance of TSpatialSearch, it is required to specify a network.

Syntax: Create(NW: TNetwork 38)

2.5.2 FindOverPasses

This method finds where 2 links intersect and add these locations to LL (LL is not cleared first). Two entries are added every time, one for each link.

There should only be overpasses, where there is also a bridge / tunnel in real life.

You can call ExportLinks 49 afterwards if you want to split the links where an overpass was found.

The FindOverPasses algorithm makes sure that exactly the same coordinates are used for both pairs of links, so snap is guaranteed if you call TImport on the resulting output from ExportLinks. See also SplitAndSnap 78.

Syntax: FindOverPasses(LL: TLocationList 147)

In standard version you are limited to networks with <10000 links.

2.5.3 FindNonConnected

This method performs a topological check:

It checks if there within a radius of all nodes in the network are links, which are not connected to the node.
Usually set radius = 0.005 km or an even smaller value.

Output is a TGISwrite with fields for node and link numbers and the distance from the first node to the node / link. Visually a line is drawn.

It returns the number of records in the result. If no records at all, then no file is generated.

Syntax: FindNonConnected(filename: string; GF: TGISformat 157; Radius: double): integer

In standard version you are limited to networks with <10000 links.

2.5.4 FindNonConnectedNodes

This method performs a topological checks:

It checks if there within a radius of all nodes in the network are other nodes, which are not directly connected to the first node.
Usually set radius = 0.005 km or an even smaller value.

Output is a TGISwrite with fields for node and link numbers and the distance from the first node to the node / link. Visually a line is drawn.

It returns the number of records in the result. If no records at all, then no file is generated.

Syntax: FindNonConnected(filename: string; GF: TGISformat 157; Radius: double): integer

In standard version you are limited to networks with <10000 links.

2.5.5 GeoJSON

When using gfGeoJSON 157 as output format in functions like FindNonConnected 74 etc, this read-only property holds the output, if filename is empty.

Property GeoJSON: string

2.5.6 GISarray

When using gfArray 157 as output format in function FindNonConnected 74, this read-only property holds the output.

Type: TGISarray 129

2.5.7 JoinNodes

This method will find groups of nodes, which are very close together, without being connected.

Since it is experimental, no further details are available.
It is not available in the DLL version.

Syntax: JoinNodes(Radius: double; Nodelists: TIntegerLists 147);

2.5.8 MBRselect

When set to true, selections are done as a square around the center point, rather than a circle (radius).
This makes the selection faster.

Type: boolean (default: false)

2.5.9 NearestLink

This function will locate which link you are driving on, when both GPS coordinate and bearing (0-359) are known.
0 = North, 90 = East, 180 = South, 270 = West.

This is especially useful, when there are many intersecting roads or two parallel roads.

Specify a search radius, such as 0.025 km, since it uses SelectLinks 77 internally.

The result is returned as a list of possible matches, with the best guess at the top of the list.

Syntax: function NearestLink(P: TFloatPoint 157; Bearing, SearchRadius: double): TGPSMatchList 146;

See also NearestLocation 75

2.5.10 NearestLocation

This locates the nearest location from P.

It returns this information:

- Location
- Side of the link (-1: Left or +1: Right)

- Distance
- Coordinates of location on link

A typical use is converting large amounts of GPS coordinates into network locations. An example of performance is:
A street network with 200,000 links, latitude/longitude coordinates: 2000 calcs per sec (using an AMD A6-5400K)

Larger street networks makes it slightly slower, while using projected coordinates makes it faster. Setting MaxVerticesPerCell 29 at a lower value than default can also make it slightly faster.

Syntax: NearestLocation(P: TFloatPoint 157; var Loc: TLocation 158; var side: integer; var distance: double; var Pnew: TFloatPoint 157)

See also DistanceToLink 48, NearestLocationSimple 76 and SkipLinks 77.

2.5.11 NearestLocationSimple

This finds the nearest location from P.

Syntax: NearestLocationSimple(P: TFloatPoint 157): TLocation 158

See also DistanceToLinkSimple 48, NearestLocation 75 and SkipLinks 77.

2.5.12 NearestLocationSimpleList

Same as NearestLocationSimple 76, except it processes LL.

Syntax: NearestLocationSimpleList(LL: TLocationList 147)

2.5.13 NearestNode

This locates the nearest node from P. Returns distance to the node too.

Syntax: NearestNode(P: TFloatPoint 157; var node: integer; var distance: double)

See also NearestNodeSimple 76

2.5.14 NearestNodeSimple

This locates the nearest node from P.

Syntax: NearestNodeSimple(P: TFloatPoint 157): integer;

2.5.15 NearestVertex

This locates the nearest vertex from P.

It returns this information:
- Link
- Index of vertex (0-based)
- Distance

Syntax: NearestVertex(P: TFloatPoint 157; var link, index: integer; var distance: double)

See also GetGISSection 53

2.5.16 SelectLinks

This method selects all links within a radius from P.

Result is returned as a list of links in List and as a bit pattern in BA.

Syntax: SelectLinks(P: TFloatPoint 157; Radius: double; List: TIntegerList 147; BA: TBitArray 148)

See also SkipLinks 77.

2.5.17 SelectLinksArray

Same as SelectLinks 77, but result is only returned in the array.

Syntax: SelectLinksArray(P: TFloatPoint 157; Radius: double; BA: TBitArray 148)

2.5.18 SelectLinksList

Same as SelectLinks 77, but result is only returned in the list.

Syntax: SelectLinksList(P: TFloatPoint 157; Radius: double; List: TIntegerList 147)

2.5.19 SelectNodes

This method selects all nodes within a radius from P.

Result is returned as a list of nodes in List and as a bit pattern in BA.

Syntax: SelectNodes(P: TFloatPoint 157; Radius: double; List: TIntegerList 147; BA: TBitArray 148)

2.5.20 SelectNodesArray

Same as SelectNodes 77, but result is only returned in the array.

Syntax: SelectNodesArray(P: TFloatPoint 157; Radius: double; BA: TBitArray 148)

2.5.21 SelectNodesList

Same as SelectNodes 77, but result is only returned in the list.

Syntax: SelectNodesList(P: TFloatPoint 157; Radius: double; List: TIntegerList 147)

2.5.22 SkipLinks

This property defines if any of the links should be skipped in methods NearestLocation 75 and SelectLinks 77.

Default: nil

Type: TBitArray

2.5.23 SkipNodes

This property defines if any of the nodes should be skipped in methods NearestNode[76] and SelectNode[77].

Default: nil

Type: TBitArray

2.5.24 SplitAndSnap

This methods performs a search around nodes with degree <3. If any location on a link is found in the search, and the link is not connected to the original node and not a node at the same time (i.e. start or end of the link), the location is added to LL (LL is not cleared first). The same coordinate is also added to LL, with the original node as reference together with special codes, that can be handled by ExportLinks[49], so links can be split and updated correctly for exact snap in future TImport[26] runs.

You can also choose to call ExportLocationList[50] to visually check and edit, where issues has been found.

The method returns the number of positive searches. LL holds ~2-3 times as many items.

Syntax: SplitAndSnap(Radius: double; LL: TLocationList[147]): integer

In standard version you are limited to networks with <10000 links.

2.6 TCalc

This class is used for one-to-many route calculations, the Dijkstra algorithm is used. Use TRouteCalc[101] for one-to-one route calculations.

Typical sequence when using TCalc is like this:

Call SetTime[63] and/or SetCost[62] if you want to calculate more than just length of routes.

Define which criteria you want and call the corresponding method: SetShortest[93], SetFastest[93] or SetCheapest[92].

The SkipLinkList[93] can be used to ignore certain links in the route calculations.

Eventually set MaxCost[89], if you want to create a smaller isochrone than otherwise.

MaxSpeed[89] can be used to override the speed for the network, in case of slow vehicles.

NoDriveThrough[91] can be set to avoid areas, where you are not allowed to drive through ("no access").

Finally call one of the actual isochrone methods, possibly followed by additional query methods:

If you just want cost:

- IsoCost[82] or IsoCostList[82] or IsoCostListN[82] > NodeCost[91] or LinkCost[86]
- IsoCostDyn[82] or IsoCostListDyn[82] or IsoCostListNDyn[83] > NodeCost[91] or LinkCostDyn[87]
- IsoCostDynApproach[97] > LinkCostDynApproach[98]

If you want cost and the route:
- IsoCost 82 or IsoCostList 82 > RouteFind 91 > RouteCost 91, RouteLength 61 and / or RouteTime 92
- IsoCostDyn 82 or IsoCostListDyn 82 or IsoCostListNDyn 83 > RouteFindDyn 92 > RouteCost 91, RouteLength 61 and / or RouteTime 92
- IsoCostDynApproach 97 > RouteFindDynApproach 99 > RouteCost 91, RouteLength 61 and / or RouteTime 92

Matrix methods: (to TMatrix 159)
- Matrix 56
- Matrix2 87
- MatrixDyn 56
- MatrixDyn2 88

Matrix methods: (output to GIS files)
- MatrixOut 88
- MatrixDynOut 88
- MatrixPOut 89

Other methods:
- Nearest 90
- NearestDyn 90
- NearestOpen 90
- NearestOpenDyn 90

Methods for isochrones (see also here 16):
1. DriveTimeSimple 80
2. IsoPoly 85
3. AlphaShape 96 (Pro only)
4. IsoLinkDriveTime 83

It is worth noting that Cost in TNetwork is different from Cost in TCalc:

- In TNetwork it is a generalized cost for a single link (or turn delay), much similar to the length or time of a link.

- In TCalc it is the result of a route / isochrone calculation from a starting point to somewhere else. The cost can be either distance (SetShortest 93), time (SetFastest 93) or "cost" (SetCheapest 92), depending upon which criteria has been set up.

2.6.1 Create

When creating an instance of TCalc, it is required to specify a network and if turnmode should be true or false.

If you are going to use SetCheapest 92 in combination with negative costs, turnmode has to be true.

Syntax: Create(NW: TNetwork 38; Turnmode: boolean)

2.6.2 DecimalsDist

When generating file output, you can use this property to define number of decimals in distances.
A negative number means up to 10 decimals.

Default: -1

Type: smallint

2.6.3 DecimalsTime

When generating file output, you can use this property to define number of decimals in time and time spans.
A negative number means up to 10 decimals.

Default: -1

Type: smallint

2.6.4 DistanceUnit

When generating output to disk, you can use this property to use miles in the output.

This affects:

MatrixOut 88, MatrixPOut 89, and MatrixDynOut 88
NearestNDyn 103 and NearestNP 103
RoutePairs 104 and RoutePairsP 104

Here it is the steplist values, which may get changed, if using shortest path:
IsoLinkDriveTime 83 and IsoLinkDriveTimeDyn 84
AlphaShape 96 and DriveTimeSimpleDyn 80

Default: duKm

Type: TDistanceUnit 156

2.6.5 DriveTimeSimpleDyn

This is a simpler version of the voronoi 116 based method for drivetime isochrones. It uses a single location as center.

Angle should be in the range 0 to 45, with 0 giving the convex hull. Small values make the isochrone follow the network more closely and larger values makes it closer to the convex hull.

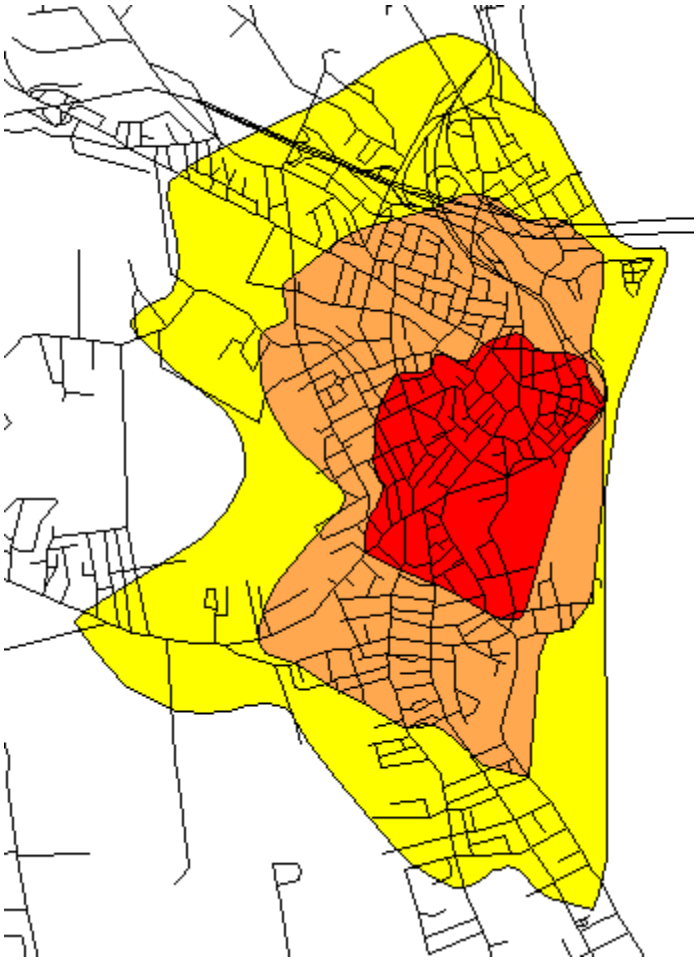
Smoothing 100 can be enabled, but may give degenerate results when combined with multiple steps.

If IncludeLinks is false, only the nodes of the network is used when generating the output.
Much faster, but also less accurate.

Syntax: DriveTimeSimpleDyn(filename: string; GF: TGISformat 157; location: TLocation; Steps: TStepList 147; angle: double; doughnut, IncludeLinks: boolean);

See also Isochrones - overview 16

Example with 1-2-3 km, angle = 3 degree, doughnut = true and smoothing = (5,3,5):



2.6.6 GeoJSON

When using gfGeoJSON 157 as output format in functions like MatrixOut 88 etc, this read-only property holds the output, if filename is empty.

Property GeoJSON: string

2.6.7 GISarray

When using gfArray 157 as output format in functions like MatrixOut 88 etc, this read-only property holds the output.

Type: TGISarray 129

2.6.8 IgnoreOneway

Set this property to true, if you want to ignore one-way restrictions in the route calculations.

Default: false

Type: boolean

2.6.9 IsoCost

This method calculates an isochrone from the node. The size of the isochrone can be restricted by setting MaxCost 89.

Syntax: IsoCost(node: integer)

2.6.10 IsoCostDyn

This method calculates an isochrone from the location. The size of the isochrone can be restricted by setting MaxCost 89.

An error will be raised if location is on a loop link. Check with LoopLink 56 function in advance.

Syntax: IsoCostDyn(Loc: TLocation 158)

2.6.11 IsoCostList

This method calculates an isochrone from node, which extends until all nodes in NL has been reached. If MaxCost 89 has been set, it may stop sooner.

Syntax: IsoCostList(node: integer; NL: TIntegerList 147)

2.6.12 IsoCostListDyn

This method calculates an isochrone from the location, which extends until all locations in LL has been reached.

An error will be raised if location is on a loop link. Check with LoopLink 56 function in advance.

Syntax: IsoCostListDyn(Loc: TLocation 158; LL: TLocationList 147)

2.6.13 IsoCostListN

This method calculates an isochrone from node, which extends until the first N nodes in NL has been reached.

If MaxCost 89 has been set, it may stop sooner.

Result is returned in IL as a sorted index into NL. Length of IL may be < N, if not all nodes in NL is reached.

Example:
NL = {100, 200, 300, 400, 500, 600}
N = 3
cost(100) = 32
cost(200) = 45
cost(300) = 103
cost(400) = 77
cost(500) = 80
cost(600) = 10

Output: IL = {5, 0, 1}
Cost of index 5, 0 and 1 is 10, 32 and 45.

Syntax: IsoCostListN(node: integer; NL, IL: TIntegerList 147; N: integer)

2.6.14 IsoCostListNDyn

Same method as IsoCostListN 82, just using locations instead:

An error will be raised if location is on a loop link. Check with LoopLink 56 function in advance.

Syntax: IsoCostListNDyn(Loc: TLocation 158; LL: TLocationList 147; IL: TIntegerList 147; N: integer)

2.6.15 IsoCostMulti

This method calculates an isochrone from a list of facilities (NL, nodes), identifying which facility is nearest. No more than 65535 nodes are allowed in the list.

For each facility you can define if there is an offset, i.e. a cost>0 value that is added to the cost. This can for instance be used to create drivetime regions around a number of fire-stations, which has different start times. Set parameter to nil, if offset=0 for all facilities.

You can set MaxCost if you only want smaller isochrones in your calculations.

BestCost returns the cost to the nearest facility.
BestFacility returns an index into NL. If value is 65535, it means the node wasn't in reach of any facility.

Both have as many elements as there are nodes.

You can not combine this method with subsequent calls to RouteFind 91, LinkCostDyn 87, NodeCost 91 or any other methods. You should only use the two output parameters as result.

Syntax: IsoCostMulti(NL: TIntegerList 147; Offset: TCostArray 156; var BestCost: TCostArray 156; var BestFacility: TWordArray 163)

2.6.16 IsoLinkDriveTime

This method shows the distance from one more centers (nodes) to each location on a street network.

Internally it uses IsoCostMulti 83 and shares the NL and Offset parameters with this method.

StepList is a number of cost values, indicating which values are used as steps in generating the output. For instance steps 1, 2 and 3 will generate steps 0-1, 1-2 and 2-3.

SL is a list of identifiers for the output. As many as there are items in NL. If SL=nil, you will get 0,1,2... identifiers instead.

Output is a polyline theme and the polylines are dynamically segmented to show the exact position where it changes, which center is the nearest. Polylines are oriented so they point away from the center.

If you run this method in turnmode, certain smaller details next to actual turn restrictions may come out wrong.

Syntax: IsoLinkDriveTime(filename: string; GF: TGISformat 157; NL: TIntegerList 147; Offset: TCostArray 156; StepList: TStepList 147; SL: TStringList 151)

See also Isochrones - overview 16

Example:

2.6.17 IsoLinkDriveTimeDyn

The same as IsoLinkDriveTime 83, except it uses a single location as center.

Syntax: IsoLinkDriveTimeDyn(filename: string; GF: TGISformat 157; loc: TLocation 158; OffSet: TCost 156; StepList: TStepList 147)

2.6.18 IsoLinkServiceArea

This method shows which center (node) is the nearest on a street network.

Internally it uses IsoCostMulti 83 and shares the NL and Offset parameters with this method.

Output is a polyline theme and the polylines are dynamically segmented to show the exact position where it changes, which center is the nearest. Polylines are oriented so they point away from the center.

If you run this method in turnmode, certain smaller details next to actual turn restrictions may come out wrong.

Syntax: IsoLinkServiceArea(filename: string; GF: TGISformat 157; NL: TIntegerList 147; Offset: TCostArray 156)

Example:

2.6.19 IsoPoly

This method is for calculating input to the voronoi 116-based methods for drivetime isochrone, service areas etc.

Main input is two lists with nodes and locations. If you only have nodes or locations, set the other list parameter to nil. No more than 65535 items are allowed in the lists in total.

The lists contain your facilities or just a single facility. Isochrones are calculated for each of them and the output keeps track of which node / location was the nearest and cost. This is done for all nodes in the network.

For each facility you can define if there is an offset, i.e. a cost>0 value that is added to the cost. This can for instance be used to create drivetime regions around a number of fire-stations, which has different start times. Set parameter to nil, if offset=0 for all facilities.

Addnodes can be used to define if the calculation should be done for additional locations along long links. If the value of addnodes is, say 1 (km), and a link is 3.6 km long, additional nodes will be inserted at 0.9, 1.8 and 2.7 km in the output. No additional nodes are added if the link is shorter than 1 km.

MaxCost[89] & MBR can both be used to define if the isochrone should be restricted in size. If MaxCost[89]=0 and MBR=cFRNull, the whole network is covered.

Includelinks can be used to decide which links should be part of the output. Nodes are only part of the output if they are connected to at least one link, that is included. Specify nil, if all links should be included.

If you run this method in turnmode and with addnodes<>0, certain smaller details next to actual turn restrictions may come out wrong.

AddNodesEx can be used to define a smaller value of addnodes, for selected links which require this.
AddNodesExList is a parameter, which defines the selection.
This can typically be used for 2 parallel roads (motorways), which would otherwise end up as zig-zag on a map.

See also IsoPolyFast[86], IsoPolyRandomnization[86] and Isochrones - overview[16].

Syntax: IsoPoly(NL: TIntegerList[147]; LL: TLocationList[147]; Offset: TCostArray[156]; addnodes, addnodesEx: TCost[156]; MBR: TFloatRect[157]; includelinks, addnodesExLinks: TBitArray[148]): TPolyGeneration[149]

2.6.20 IsoPolyFast

This function is the same as IsoPoly[85], except the MBR parameter is replaced with a buffer parameter.

Internally the function automatically calculates MBR from the items in NL and LL, MaxCost[89] and buffer. This makes it much faster and the recommended solution for preparing input for drive time polygons.

Buffer should be specified in km. Suggested values are 2 km for urban areas and 10 - 20 km in rural areas (for voronoi[118] calculations).
If you use the output for Alpha shapes[96], then buffer = 0 is sufficient.

Syntax: IsoPolyFast(NL: TIntegerList[147]; LL: TLocationList[147]; Offset: TCostArray[156]; addnodes, addnodesEx, buffer: TCost[156]; includelinks, addnodesExLinks: TBitArray[148]): TPolyGeneration[149]

2.6.21 IsoPolyRandomnization

Set this property to true, if you want to add a very small randomnization to the coordinates output from the IsoPoly[85] methods.

This is sometimes needed if you are using low values for the addnodes parameter due to numerical instabilities in the

Default: false

Type: boolean

2.6.22 LinkCost

TurnMode[95] = false:
Returns the maximum cost of the two end nodes of the link.

TurnMode[95] = true:

Link>0: Returns the cost of going to the ToNode of the link.
Link<0: Returns the cost of going to the FromNode of the link.

Syntax: LinkCost(link: integer): TCost 156

2.6.23 LinkCostDyn

Returns the cost of getting to a specific location of a link.
This method can be used after a call to either IsoCost 82 or IsoCostDyn 82 function.

Syntax: LinkCostDyn(loc: TLocation 158): TCost 156

2.6.24 Matrix

This method calculates a matrix, based upon the nodes in NL.
Eventually set extra = true for use with TTSP 139 - see explanation in TTSPmode 162.

Set symmetric = true, if you can do with a symmetric matrix. This makes calculations faster.
But it is not recommended if you have oneway restrictions in the network.

If you want to do a N x M matrix rather than N x N, use Matrix2 87.

Syntax: Matrix(NL: TIntegerList 147; extra,symmetric: boolean): TMatrix 159

2.6.25 Matrix2

This method calculates a matrix, based upon the nodes in NL1 and NL2. Calculations are fastest if NL1 is the smallest list.

See also Matrix 87.

Syntax: Matrix2(NL1, NL2: TIntegerList 147): TMatrix 159

2.6.26 MatrixBuffer

When calculating matrices for a small area in a big street network, it is possible to speed up calculations by restricting calculations to the relevant part + a buffer.
Experience show a factor 2 can be obtained in the best case.

If the buffer gets specified too small, you risk not finding the correct route or even not finding a route at all.

We recommend using 5 km for urban areas, in more rural areas use a larger value.

If you use 0 or a negative value, the whole network is considered (default).

Applies to: Matrix 56, Matrix2 87, MatrixDyn 56, MatrixDyn2 88, MatrixOut 88, MatrixDynOut 88 and MatrixPOut 89.

Default: 0 km

Property MatrixBuffer: double;

2.6.27 MatrixDyn

Same method as Matrix 87, just with locations instead of nodes:

Syntax: MatrixDyn(LL: TLocationList 147; extra, symmetric: boolean): TMatrix 159

2.6.28 MatrixDyn2

Same method as Matrix2 87, just with locations instead of nodes:

Syntax: MatrixDyn2(LL1, LL2: TLocationList 147): TMatrix 159

2.6.29 MatrixDynOut

Same method as MatrixOut 88, just with locations instead of nodes.

It also adds an additional parameter nearestopen, which updates locations in LL1 and LL2 where needed by making calls to NearestOpenDyn 90.

If you set MaxCost 89, it is used as a filter on the output (but it doesn't go faster).

Syntax: MatrixDynOut(filename: string; GF: TGISformat 157; LL1, LL2: TLocationList 147; SL1, SL2: TStringList 151; dist, time, cost, directdist, symmetric, routeobject, nearestopen: boolean)

2.6.30 MatrixOut

This method calculates a matrix, based upon the nodes in NL1 and NL2.

SL1 and SL2 contains strings, identifying the records. This can be as simple as the record ID or another text.

SL1 and NL1 need to hold the same amount of items.
SL2 and NL2 need to hold the same amount of items.

Optionally SL1 and SL2 can be nil, then list index is used in the output.
If SL1 or SL2 contains all integers, the field type in the output is generated accordingly.

Dist, time, cost and directdist can be set to false/true to determine which fields should be included in the output.
Set routeobject = true, if you want the route to be part of the output.

If symmetric is true, NL2 should be the same as NL1 and only combinations in one direction between members in NL1 is part of the output.

If threads 94 > 1, symmetric is ignored / is always false.

If you set MaxCost 89, it is used as a filter on the output (but it doesn't go faster).

Output files can get very big if you have many items in the lists, especially if routeobject is also true. See the notes about TGISwrite 122.

Syntax: MatrixOut(filename: string; GF: TGISformat 157; NL1,NL2: TIntegerList 147; SL1,SL2: TStringList 151; dist, time, cost, directdist, symmetric, routeobject: boolean)

2.6.31 MatrixPOut

Same method as MatrixDynOut 88, just with positions instead of locations.
This means you should use the coordinate of TLocationList 158 items, rather than the locations.

It also adds an additional parameter offroadspeed (km/h), which allow you to include the offroad part in the output. If speed=0, then it is skipped.

Another additional parameter is skiplinkbit which determines if the skiplinkbit from the attribute field, is used in the spatial search.

If nearestopen is "active" for a specific element (i.e. another element is used as the starting point, rather than the nearest), then the offroad part is skipped.

If you set MaxCost 89, it is used as a filter on the output (but it doesn't go faster).

If the position for two elements in LL1 and LL2 is the same, then the distance etc. becomes 0, even if offroad speed is defined.

Syntax: MatrixPOut(filename: string; GF: TGISformat 157; LL1, LL2: TLocationList 147; SL1, SL2: TStringList 151; dist, time, cost, directdist, symmetric, routeobject, nearestopen: boolean; offroadspeed: double; skiplinkbit: boolean)

2.6.32 MaxCost

This property can be used to restrict the size of isochrones, nearest N calculations etc.
Matrix functions for writing to disk are also affected by MaxCost (MatrixOut 88, MatrixDynOut 88, MatrixPOut 89).
Unit is whatever is used as cost criteria: Cost, time or distance.

Default: 0

Type: TCost 156

2.6.33 MaxCostExt

When calculating matrices, isochrones etc. in dynamic segmentation mode, the maximum cost (distance / time / generic cost) of the links is used to guarantee correct results in all situations.

If this maximum cost is very high, it may make the calculation time much longer in large networks. By setting this value, you can restrict it, with the risk slightly wrong results are returned in rare situations.

Unit is whatever is used as cost criteria: Cost, time or distance. 5 may be a good choice for a value, if criteria is time or distance.

Default: 0

Type: TCost 156

2.6.34 MaxSpeed

This property can be used to limit the speed of all links in the network, if you are calculating for a vehicle that can not go as fast as is otherwise possible.

It only affects the route choice when working in Fastest 93 mode.

Default: 0

Type: TCost 156

2.6.35 MIpen

Setting this property allows you to control the line style of the output of these methods: MatrixOut 88, MatrixPOut 89, MatrixDynOut 88, NearestNDyn 103, NearestNP 103, TrafficAssignment 109 and TrafficAssignmentDyn 109.

When you call it from the MapBasic DLL, the color is in MapInfo style (BGR), otherwise it is ordinary windows style (RGB).

Type: TMIpen 159

2.6.36 Nearest

This method will locate the nearest item in NL, calculated from a node. It returns the index of the item.

If returning -1, nothing was found.

Syntax: Nearest(node: integer; NL: TIntegerList 147): integer

2.6.37 NearestDyn

This method will locate the nearest item in LL, calculated from the location. It returns the index of the item.

If returning -1, nothing was found.

Syntax: NearestDyn(Loc: TLocation 158; LL: TLocationList 147): integer

2.6.38 NearestOpen

This method will find the nearest open node, from a starting node. An open node is one where at least one of the connected links is open for driving.

Syntax: NearestOpen(node: integer; var NearestNode,NearestLink: integer; var cost: TCost 156)

2.6.39 NearestOpenDyn

This method will find the nearest open link and node, from a starting location. An open node is one where at least one of the connected links is open for driving.

Obstacles it ignores while doing so:
1) Oneway restrictions
2) Limits
3) Links being skipped
4) NoDriveThrough setting

Syntax: NearestOpenDyn(Loc: TLocation 158; var NearestNode, NearestLink: integer; var cost: TCost 156)

2.6.40 NodeCost

Returns the cost for a single node. This requires that an isochrone has been calculated previously.

Syntax: NodeCost(node: integer): TCost 156

2.6.41 NoDriveThrough

This property controls if the attribute 5 bit for NoDriveThrough areas should be respected in calculations.

It is actually only respected in TRouteCalc methods, but for technical reasons it is a TCalc property.

Default: false

Type: boolean

2.6.42 RelativeSpeed

This property can be used to reduce the relative speed of all links in the network, if you are calculating for a vehicle that can not go as fast as is otherwise possible.

Valid range: 0.01 to 1

Default: 1

Type: double

2.6.43 RouteCost

This method returns the cost of a route, according to how Cost has been setup 92.

See also RouteTime 92 and RouteLength 61.

Syntax: RouteCost(route: TRoute 161): TCost 156

2.6.44 RouteFind

This method will return a TRoute list to a node, if a route / isochrone has already been calculated from another node.

2 examples with the same functionality:

```
TCalc.IsoCost(node1)
cost = TCalc.NodeCost(node2)
route = TCalc.RouteFind(node2)

cost = TRouteCalc.Route(node1,node2)
route = TCalc.RouteFind(node2)
```

IsoCost 82 method is faster if you have many calculations to do for the same node1. But class TRouteCalc 101 offers more fine-tuning options.

Syntax: RouteFind(node: integer): TRoute 161

2.6.45 RouteFindDyn

This method will return a TRoute list to a location, if an isochrone has already been calculated from another location.

2 examples with almost the same functionality:

TCalc.IsoCostDyn(location1)
cost = TCalc.RouteFindDyn(location2,route)

cost = TRouteCalc.RouteDynEx(location1,location2,route)

IsoCostDyn 82 method is faster if you have many calculations to do for the same location1. But class TRouteCalc 101 offers more fine-tuning options.

It returns a high number (1e38) if no route is found.

Syntax: RouteFindDyn(Loc: TLocation 158; var route: TRoute 161): TCost 156

2.6.46 RouteTime

This method returns the time (minutes) of a route, according to how Time has been setup 92.

See also RouteCost 91 and RouteLength 61.

Syntax: RouteTime(route: TRoute 161): TCost 156

2.6.47 SelectClosedLinks

This method can be used for selecting from the street network.

Output is stored in BA. New selections are set and added to any previous selections in BA.

It selects all links which are closed for the current setup, according to limits.
If includeoneway is true, it will also select links where both oneway bits 5 are set (512 + 1024).

Syntax: SelectClosedLinks(BA: TBitArray; includeoneway: boolean);

2.6.48 SetCheapest

This sets the calculation target to be cost. At the same time it can be specified if turn restrictions should be included.

If you have defined any negative costs (TNetwork.SetCost 62), it is important to set turnmode = true, when creating the object 79.
Even so, it is experimental, if you use negative costs in route calculations.

Syntax: SetCheapest(turncosts: boolean)

2.6.49 SetCost

This defines which cost array should be used in cheapest 92 route calculations.

Default: 0 as index

Syntax: SetCost(index: integer)

2.6.50 SetFastest

This sets the calculation target to be time. At the same time it can be specified if turn restrictions should be included.

Syntax: SetFastest(turncosts: boolean)

2.6.51 SetLimit

This allows you to restrict routing to links where a limit exists. See Limit 8 for further details.

LimitID is from 1 to 9 and value is from 0 to 255.

Default is value = 0, i.e. no restriction.

Syntax: SetLimit(LimitID: integer; value: byte)

2.6.52 SetShortest

This sets the calculation target to be distance. At the same time it can be specified if turn restrictions should be included.

If they are included, only restrictions (<0) are applied. Delays (>0) are ignored.

Default: SetShortest(false)

Syntax: SetShortest(turncosts: boolean)

2.6.53 SetSkipLinkList

You can set up a list of links that should be excluded in routing.

Default: no list

See also SetSkipNodeList 108.

Syntax: SetSkipLinkList(list: TBitArray 148)

2.6.54 SetTime

This defines which time array should be used in fastest 93 route calculations.

Default: 0 as index

Syntax: SetTime(index: integer)

2.6.55 SetTurn

This defines which turn restriction array should be used, when turncosts = true in SetCheapest 92, SetFastest 93 or SetShortest 93.

Default: 0 as index

Syntax: SetTurn(index: integer)

2.6.56 SkipCulDeSacOptimization

This property controls if cul-de-sac optimization should be skipped during route calculations, increasing calculation time by 25-30%.

It can be used to make sure RouteDynApproach 107 calculations gives the same result as IsoCostDyn 82 followed by RouteFindDyn 92 - even in rare situations.

Default: false

Type: boolean

2.6.57 SmartInit

When doing short routes / small isochrones in very large networks (>2 million links), we have added this feature, which allows the routing engine to only initialize the network as it works it way through it, by using the spatial index for determing when new areas are visited.

It can improve performance by a factor 2-5 in such cases. The advantage disappears when length of routes reaches app. 50 km. For very long routes, it is even a disadvantage.

If you set it and use the object in instantiating the TDrivingDirections 110 class, it will also use smartinit routing.
It does so by testing if distance is below 50 km (hardcoded limit).

Default: false

Type: boolean

2.6.58 Starttime

This property is used for defining when a route calculation starts. Not implemented yet.

Type: TCost 156

2.6.59 SubNetSimple

This method calculates if a network has subnets. A subnet is defined as a part of the network, which isn't connected to the rest of the network. It can typically be an island without a ferry or a similar situation.

This is done with IgnoreOneWay 81 set to true temporarily, so one-way restrictions may in fact make even more links in-accessible. See function SubNetEx 108 on how to detect such situations.

It returns true if there are subnets.

See also SubNet 101 and SubNetEx 108.

Syntax: SubNetSimple: boolean

2.6.60 Threads

Set this property to decide how many threads are used when calling these methods:

IsoCostMulti 83
IsoLinkDriveTime 83 (*)

IsoLinkServiceArea 84 (*)
IsoPoly 85
IsoPolyFast 86

Matrix 87
Matrix2 87
MatrixDyn 88
MatrixDyn2 88
MatrixDynCurbIsochrone 107

MatrixOut 88 (*)
MatrixDynOut 88 (*)
MatrixPOut 89 (*)

Methods that involve writing a lot to disk (*), do not always benefit much from running multi-threaded. Some fileformats are even slower in multi-threaded mode.

The setting only applies in RW Net Pro. Valid values are 1 to 256. Default is 1.
We do not recommend using higher than the "number of cores - 1".

When running with multiple threads, additional TCalc objects are created internally.
This means a much higher amount of memory is allocated. This is especially something to be aware of with large street networks.

Progress events for these functions are disabled when threads > 1.

Type: integer

2.6.61 TimeFormatAsString

When set as true, time values in matrix output is generated in a human readable format, rather than minutes.

Examples:
4m 30s
3h 23m 05s
999h 00m 02s

Max value is 999 hours.

It affects: MatrixOut 88, MatrixDynOut 88, MatrixPOut 89, NearestNDyn 103, NearestNP 103, RoutePairs 104 and RoutePairsP 104.

Default: false

Type: boolean

2.6.62 Turnmode

This read-only property returns if the object was created 79 with turnmode enabled.

Type: boolean

2.6.63 UTurnAllowed

Defines if U-turns are allowed when Turnmode = true.

False: All U-turns are banned.
True: All U-turns are allowed, unless banned through attribute 5 settings.

U-turns are always allowed on cul-de-sac 47 links.

Default: false

Type: boolean

2.6.64 Pro methods

2.6.64.1 AlphaShape

Alpha shapes is one of many ways to create isochrones around a set of points.
It requires the presence of alphashape.dll or alphashape64.dll.

See also Isochrones - overview 16

Syntax: AlphaShape(filename: string; GF: TGISFormat 157; PG: TPolyGeneration 149; SL: TStepList 147; IncludeIslands: boolean);

2.6.64.2 CenterLocation1

This method finds the center location of a network, the one which is halfway along the longest route in the network.
Route is calculated as shortest / fastest / cheapest in the normal way.

This may not be the same as center of gravity.

Syntax: CenterLocation1: TLocation;

2.6.64.3 CenterNode

This method finds the center node of a network, the one which minimizes this expression:

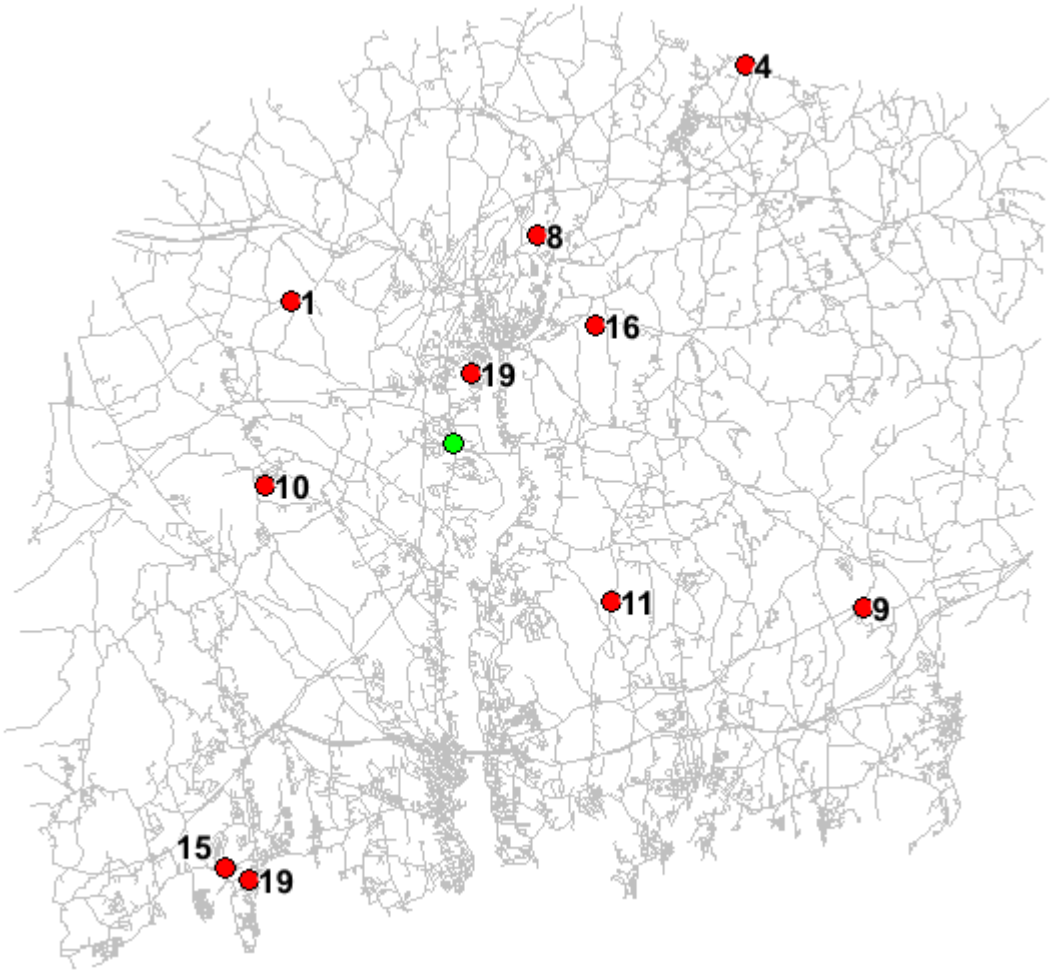
∑ Weight(node) * distance(node, CenterNode)

Parameter nodeweights need to have as many elements as NodeCount 57 +1 and contain 0's or positive weights.

The method is aimed at having not too many elements > 0 or it gets slow.

Syntax: CenterNode(var nodeweights: TCostArray 156): integer;

Example with 10 nodes with weights and the green centernode:



2.6.64.4 IsoCostDynApproach

This method calculates an isochrone from the location, but with a specific approach. The size of the isochrone can be restricted by setting MaxCost 89.

An error will be raised if location is on a loop link. Check with LoopLink 56 function in advance.

Requires turnmode 95 = true !

Syntax: IsoCostDynApproach(Loc: TLocation 158; Approach: TApproach 154)

2.6.64.5 IsoCostListDynApproach

This method calculates an isochrone from the location, but with a specific approach. It stops when all items in LL has been reached.

An error will be raised if location is on a loop link. Check with LoopLink 56 function in advance.

Requires turnmode 95 = true !

Syntax: IsoCostListDynApproach(Loc: TLocation 158; LL: TLocationList 147; Approach: TApproach 154)

2.6.64.6 LinkCostDynApproach

Returns the cost of getting to a specific location of a link and with a specific approach.
This method can be used after a call to IsoCostDynApproach 97 method.

2 examples with the same functionality:

TCalc.IsoCostDynApproach 97(location1,approach1)
cost = TCalc.LinkCostDynApproach(location2,approach2)

cost = TRouteCalc.RouteDynApproach 107(location1,location2,approach1,approach2)

If location1.link = location2.link you will have to use the TRouteCalc method.

Syntax: LinkCostDynApproach(loc: TLocation 158; approach: TApproach 154): TCost 156

2.6.64.7 MST

This method calculates a minimum spanning tree for the network, using Prims algorithm. Result is stored in links as 1's if the link is part of the tree.

By default length is used as cost, but by calling SetFastest 93 or SetCheapest 92, you can change to another criteria.

Oneway restrictions are not taken into account, neither is limits or the SkipLinkList 93.

Performance examples:
13,500 links: 0.5 sec
200,000 links: 165 sec

See also SteinerTree 100 for a tree limited to a subset of the nodes.

Syntax: MST(links: TBitArray 148);

Example output, subset of larger network:

2.6.64.8 RouteFindDynApproach

This method will return a TRoute list to a location, if an isochrone has already been calculated from another location.

2 examples with the same functionality:

TCalc.IsoCostDynApproach 97(location1,approach1)
cost = TCalc.RouteFindDynApproach(location2,approach2,route)

cost = TRouteCalc.RouteDynApproachEx 108(location1,location2,approach1,approach2,route)

If location1.link = location2.link you will have to use the TRouteCalc method.

Syntax: RouteFindDynApproach(loc: TLocation 158; approach: TApproach 154; var route: TRoute 161): TCost 156

2.6.64.9 SetSmoothing

Same functionality as here 120, but for method DriveTimeSimple 80.

Syntax: SetSmoothing(passes, rounded, deviation: integer);

2.6.64.10 SteinerTree

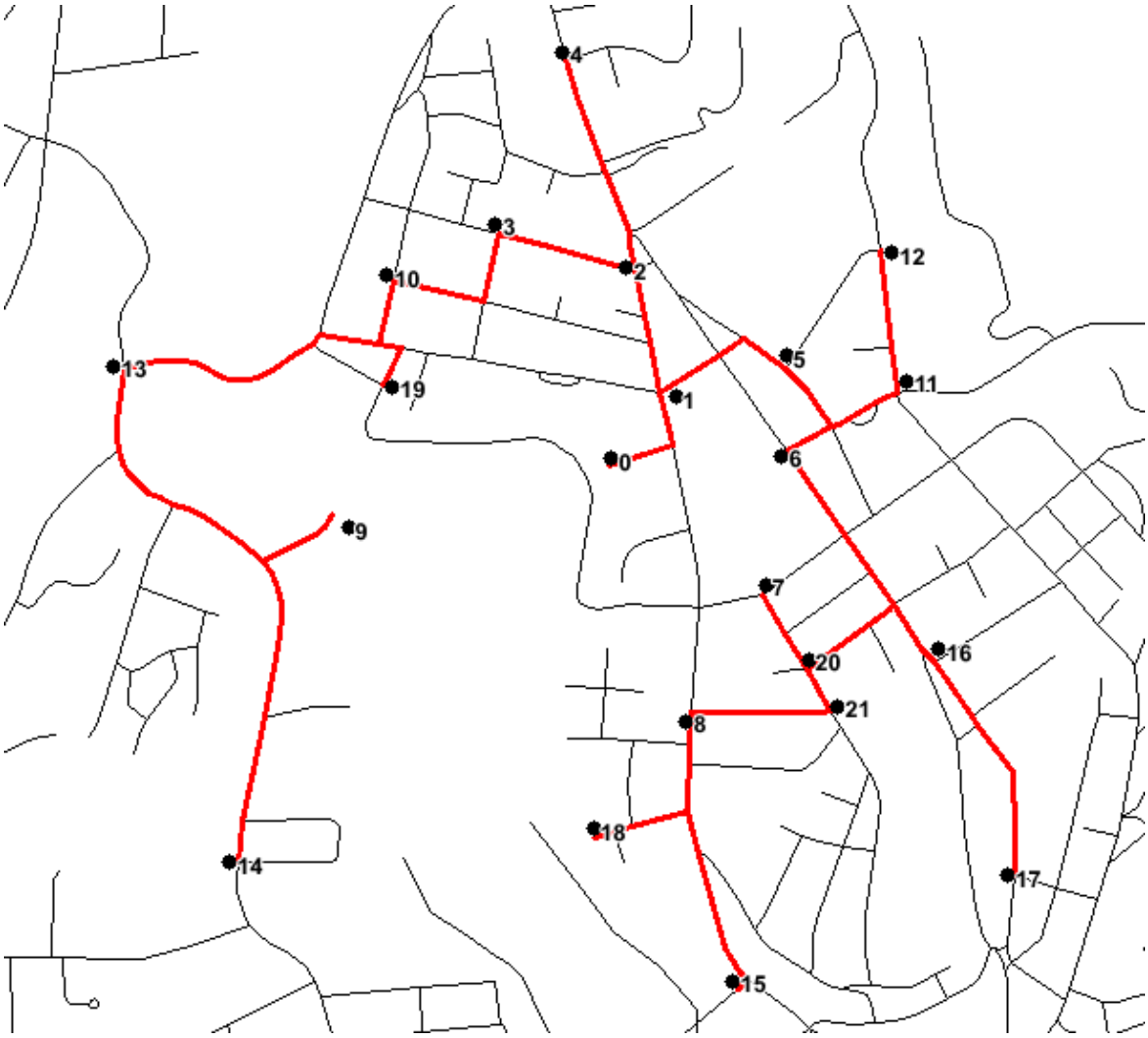
A Steiner-Tree is similar to a minimum spanning tree, with the exception you can select which nodes in the network you want to connect.

We are using an approximation to solve the problem.

See also MST 98 for an explanation.

Nodes parameter is the input, a list of nodes, while links is the output containing *true* for links that should be included.

Syntax: SteinerTree(nodes: TIntegerList 147; links: TBitArray 148);



2.6.64.11 SubNet

This method calculates which part of a network is a subnet. A subnet is defined as a part of the network, which isn't connected to the rest of the network. It can typically be an island without a ferry or a similar situation.

This is done with IgnoreOneWay 81 set to true temporarily, so one-way restrictions may in fact make even more links in-accessible. See function SubNetEx 108 on how to detect such situations.

Similarly any limits are also temporarily set to 0 while doing the calculations.

IA returns the subnet ID for each link, while the method returns the number of subnets.

0 = main net
1, 2, 3... = sub nets

The main net is defined as the one with the most links.

See also SubNetLimits 101, SubNetEx 108 and SubNetSimple 94

Syntax: SubNet(var IA: TIntegerArray 158): integer

2.6.64.12 SubNetLimits

This method is the same as SubNet method, but it takes current limits 93 into account.

Syntax: SubNetLimits(var IA: TIntegerArray 158): integer

2.6.64.13 Tree

This method allows you to calculate a tree from a single starting point, typically used for verification of the street network.

This can be seen as a simpler version of TRouteCalc.TrafficAssignment 109. It only records which links are in use and all traffic is from a single node.

Syntax: Tree(filename: string; GF: TGISformat 157; startnode: integer; var NL: TIntegerList 147)

2.6.64.14 UnusedLinks

This method can be used for locating links which are not part of a route between any 2 nodes. This is done using the current cost criteria.

Invalid objects are not marked in the output.

Syntax: UnusedLinks(links: TBitArray 148)

2.7 TRouteCalc

This class inherits all properties and methods from TCalc 78 and adds methods and properties related to one-to-one route calculations, the A* algorithm is used.

In particular it adds these properties:

Alpha 102	Makes it possible to increase speed of calculations. No further data requirements.
DuplicateLinks 102	Enables automatic checking of both directions of duplicate links

Hierarchy 106	Makes it possible to increase speed of calculations, if hierarchical information is available in the attributes 5.
SkipNodeList 108	Allows you to avoid passing through certain nodes in the network.

See also NoDriveThrough 91.

2.7.1 Alpha

This property allows you to speed up calculations. By using 1.0 as value you will still get the actual best route, while increasing the value also increases the risk of getting a route that is closer to a straight line between start and end, but not necessarily the best route.

We recommend not increasing to more than 1.3. That may improve calculation speed with a factor 10 or so: Largest improvement is seen for long routes.

Default: 1.0

See also UpdateAlphas 69.

Type: TCost 156

2.7.2 DuplicateLinks

This property controls if there should be checked for duplicate links in the calculations.

If both the start and stop link of a route has a duplicate, then 4 route combinations are calculated and the fastest / shortest / cheapest is chosen.
See TNetwork.FindDuplicateLinks 52 for an explanation.

Obviously, this slows down calculations since additional routes has to be calculated.

It affects these route methods:
RouteDyn
RouteDynEx
RoutePairs
RoutePairsP
Route Matrix Methods
TrafficAssignmentDyn

It doesn't affect these route methods:
MatrixDynCurbIsoChrone
MatrixDynCurbRoute
NearestNDyn
NearestNP
Route
RouteDynApproach
RouteDynApproachEx
TrafficAssignment

Default: true

Type: boolean

2.7.3 NearestNDyn

This method finds the N nearest elements in LL2 for every element in LL1.

Typically LL1 has many elements, such as single addresses.
LL2 has much less elements, typically some centers (schools etc).

Routes are calculated from center to address for optimized speed of calculations. If you want the other direction, call SwapOneWay 64 before and after calling the function.

If maxcost 89 is set, it is used as cutoff and less than N elements may be found.

if N=0, then all elements are returned.

SL1 and SL2 can be nil or contain text identifiers for the output.

Dist, time and cost can be set to false/true to determine which fields should be included in the output.
Set routeobject = true, if you want the route to be part of the output (slows down calculations).

Output is a GIS file with one or more of these fields:
1. ID1
2. ID2
3. N
4. Distance
5. Time
6. Cost
7. DirectDist

Syntax: NearestNDyn(filename: string; GF: TGISformat 157; LL1, LL2: TLocationList 147; N: integer; SL1, SL2: TStringList 151; dist, time, cost, directdist, routeobject: boolean)

2.7.4 NearestNP

Same method as NearestNDyn 103, just with positions instead of locations.
This means you should use the coordinate of TLocationList 158 items, rather than the locations.

It also adds an additional parameter offroadspeed (km/h), which allow you to include the offroad part in the output. If speed=0, then it is skipped.

If nearestopen is "active" for a specific element (i.e. another element is used as the starting point, rather than the nearest), then the offroad part is skipped.

Syntax: NearestNP(filename: string; GF: TGISformat 157; LL1, LL2: TLocationList 147; N: integer; SL1, SL2: TStringList 151; dist, time, cost, directdist, routeobject, nearestopen: boolean; offroadspeed: double)

2.7.5 Route

Returns the cost of a route from node1 to node2.

You can call RouteFind 91 afterwards, if you want the actual route and not just the cost.

It returns -1 if no route is found.

Syntax: Route(node1,node2: integer): TCost 156

2.7.6 RouteDyn

Returns the cost of a route from location1 to location2.

It returns -1 if no route is found.

See also RouteDynEx 104.

Syntax: RouteDyn(loc1,loc2: TLocation 158): TCost 156

2.7.7 RouteDynEx

Returns the cost of a route from location1 to location2, including the actual route.

It returns -1 if no route is found.

Syntax: RouteDynEx(loc1,loc2: TLocation 158; var Route: TRoute 161): TCost 156

2.7.8 RoutePairs

This method calculates the route between pairs of elements in LL1 and LL2, which must have the same amount of elements.

Input is the locations of the locationslists.

SL1 and SL2 can be nil or contain text identifiers for the output.

Dist, time and cost can be set to false/true to determine which fields should be included in the output.
Set routeobject = true, if you want the route to be part of the output (slows down calculations).

Output is a GIS file with one or more of these fields:
1. ID1
(2. ID2)
3. Distance
4. Time
5. Cost
6. DirectDist

See also RoutePairsGroupSize 105.

Syntax: RoutePairs(filename: string; GF: TGISformat 157; LL1,LL2: TLocationList 147; SL1,SL2: TStringList 151; dist, time, cost, directdist, routeobject, nearestopen: boolean);

2.7.9 RoutePairsP

It is the same as RoutePairs 104, except the input is the coordinates of the locationslists and it can handle an offroadspeed.

RoutePairsGroupSize 105 has not been implemented for this method yet.

Syntax: RoutePairsP(filename: string; GF: TGISformat 157; LL1,LL2: TLocationList 147; SL1,SL2: TStringList 151; dist, time, cost, directdist, routeobject, nearestopen: boolean; offroadspeed: double);

2.7.10 RoutePairsGroupSize

This property can be used to control how the RoutePairs 104 method works:

In the default state, the routes are calculated one by one.

If the value is >1, you should keep the LL1 list sorted according to location and the calculations are done using isochrones instead.
This can mean lot faster calculations, easily a factor 10, depending upon size of groups, size of network, geographical spread of locations etc.

A suggested value is 3-5.

If NoDriveThrough 91 is true, it will calculate one by one, in any case.

Default: 0

Type: integer

2.7.11 Route Matrix methods

This is a selection of methods which do the same calculations as the similar ones in the TCalc 78 class.
Main difference is the matrices are calculated as one route at a time, rather than through an isocost calculation.

This makes it faster if you want to calculate a small matrix in a large network.
Especially if your points are far apart and you have a hierarchy 6 in the data.

The methods are not multi-threaded.

RMatrix equals TCalc.Matrix 87
RMatrix2 equals TCalc.Matrix2 87
RMatrixDyn equals TCalc.MatrixDyn 88
RMatrixDyn2 equals TCalc.MatrixDyn2 88
RMatrixDynOut equals TCalc.MatrixDynOut 88
RMatrixOut equals TCalc.MatrixOut 88
RMatrixPOut equals TCalc.MatrixPOut 89

2.7.12 Pro methods

2.7.12.1 AltRouteDyn

This method calculates alternative routes between 2 locations.

It works this way:
First route is calculated the normal way.
Now, all links making up the first route are made x % more "expensive", so they are less likely to be chosen when next route is calculated.
Second route is calculated, which may include parts of the first route.
Now even more links gets marked.
Third route etc.

If NumOfRoutes=0, it stops when new routes equal one of those already calculated.
Otherwise it may stop sooner.

TimeIndex points to the timeArray which is used if you want fastest route calculation.
Set TimeIndex = -1, if you want shortest route.

SmallDeviationFactor makes sure that routes almost equal do not get generated. Default value of 0.1 = 10% seems good.

Factor is the amount of percentage already used links should be made more expensive. 1.3 to 1.4 seems good values. 1.3 equals x = 30%.

TmpCostIndex is the costArray, which is used for temporary route calculations.
Call SetCheapest 92 before calling AltRouteDyn.

ARL should be created in advance and contains the output.

Syntax: AltRouteDyn(loc1, loc2: TLocation 158; TimeIndex, TmpCostIndex, NumRoutes: integer; SmallDeviationsFactor, Factor: double; ARL: TAltRouteList 148)

2.7.12.2 Bridges

Detects if removing a link from the network, breaks up the network in separate subnets. The problematic links are marked with 1 in the IA array.

CulDeSac links are not marked, since testing for CulDeSac can easily be done with calling CulDeSac 47 for all links.
Links with oneway restrictions are not marked, use SubNetEx instead.

The function returns the number of elements set in the array.

See also SubNetEx 108

Syntax: Bridges(var IA: TIntegerArray 158): integer

2.7.12.3 CulDeSacCurb

Detects which links can not be used in curb approach mode (TTSPcurb 141), when U-turns are not allowed. The problematic links are marked with 1 in the IA array.

UTurnAllowed 96 and IgnoreOneWay 81 should be left to false, to find all problems.

Simple CulDeSac links are not marked, since testing for CulDeSac can easily be done with calling CulDeSac 47 for all links.
The function returns the number of elements set in the array.

The difference between the two functions, is this one also locates links where oneway restrictions are the cause of the problems.

Syntax: CulDeSacCurb(var IA: TIntegerArray 158): integer

2.7.12.4 Hierarchy

Set this property to true, if you want to enable hierarchical routing.
You should also have called SetHierarchyLevel 108.

If you set it and use the object in instantiating the TDrivingDirections 110 class, it will also use hierarchical routing.
It does so by first trying with hierarchy enabled and if no route was found, it will try again with hierarchy disabled.

Default: false

Type: boolean

2.7.12.5 MatrixDynCurbIsochrone

Same as MatrixDyn 88, but including curb approach, for use with TTSPcurb 141.

This version is fastest if you have more than ~10 items in LL.
See also MatrixDynCurbRoute 107.

Requires turnmode 95 = true !

Syntax: MatrixDynCurbIsochrone(LL: TLocationList 147; extra: boolean): TCurbMatrix 156

2.7.12.6 MatrixDynCurbRoute

Same as MatrixDyn 88, but including curb approach, for use with TTSPcurb 141.

This version is fastest if you have less than ~10 items in LL.
See also MatrixDynCurbIsochrone 107.

Syntax: MatrixDynCurbRoute(LL: TLocationList 147; extra: boolean): TCurbMatrix 156

2.7.12.7 RoadNameTest

This function tests the roadname as part of the driving directions. The theory is, if a road name occur more than once on a route, it may be an error and the links between the 2 occurences might have the wrong name in the database. An example:

Link 1, 2, 3: Main Street
Link 4, 5: Old Road
Link 6, 7: Main Street

Here link 4 and 5 should probably have had the name Main Street as well. The function will report such instances and then leave it to the user to decide, if any edits should be performed.

RoadFileID defines the database with road names to use with the function and NumOfRoutes defines how many random routes to calculate as part of the test.

The fields in the generated GIS file are linkID, count of links that should be changed in the same way (2 in the example above), present roadname and suggested roadname. Generally, a low number of links to be changed, indicates a higher likelihood, that it is a required change. Using a filter of count<20 is a good idea, before viewing the output. Roundabouts are always skipped in the output.

Syntax: RoadNameTest(filename: string; GF: TGISformat 157; RoadFileID, NumOfRoutes: integer);

2.7.12.8 RouteDynApproach

Returns the cost of a route from location1 to location2, but with specific approach at both locations.

See also RouteDynApproachEx 108.

Syntax: RouteDynApproach(loc1,loc2: TLocation 158; Approach1,Approach2: TApproach 154): TCost 156

2.7.12.9 RouteDynApproachEx

Returns the cost of a route from location1 to location2, but with specific approach at both locations. Actual route is also included in the output.

Syntax: RouteDynApproachEx(loc1,loc2: TLocation 158; Approach1,Approach2: TApproach 154; var Route: TRoute 161): TCost 156

2.7.12.10 SetHierarchyLevel

Sets the 4 hierarchy parameters for use in hierarchical routing. Values should be expressed in km.

Input requirement: h2 >= h3 >= h4 >= h5 >= 0.
By default all parameters are set to infinite, meaning no hierarchy is applied.

We have executed tests with TomTom (net2class field) and HERE (func_class field) databases and recommend these values:

	Km
HERE	145, 90, 40, 7
TomTom	80, 40, 20, 10

HERE tests were executed on UK data with a large number of random routes. Compared to not using a hierarchy, calculations were 11 times faster.

For short routes (<50 km) there is only little difference between using a hierarchy or not, while calculation of longer routes (>400 km) in the UK may be as much as 20-40 times faster (HERE).

We have not had time to test TomTom so accuractely yet, so the values above are just a good starting point.

In any case your dataset should have hierarchy data included and prepared in the corresponding bits in the attribute field 5.

Syntax: SetHierarchyLevel(h2, h3, h4, h5: double)

2.7.12.11 SetSkipNodeList

You can set up a list of nodes that should be excluded in routing.

Default: no list

See also SetSkipLinkList 93.

Syntax: SetSkipNodeList(list: TBitArray 148)

2.7.12.12 SubNetEx

Detects if a route between any 2 nodes can only be found when going in one of the directions. The links with the problematic one-way restrictions are identified and marked with 1 in the IA array. If any links are marked, it means the whole network isn't strongly connected.

The function returns the number of elements set in the array.

See also SubNet 101 and Bridges 106

Syntax: SubNetEx(var IA: TIntegerArray 158): integer

2.7.12.13 TrafficAssignment

This method is for assigning traffic to a street network.

Key input is TL, which holds traffic as volume between two pairs of coordinates. All traffic is allocated to the street network, using the all-or-nothing principle. For each link it keeps track of the total volume in both directions.

The map shows traffic from the red dot to all the blue dots. Width of line corresponds to volume.

Errors is used for keeping track of records within TL for which no route could be calculated. If Errors is unassigned, no records are marked.

Output contains these fields:
1. Link ID
2. Volume in forward direction
3. Volume in reverse direction

See also TrafficAssignmentDyn 109

Syntax: TrafficAssignment(filename: string; GF: TGISformat 157; TL: TTrafficList 148; var Errors: TIntegerList 147)

2.7.12.14 TrafficAssignmentDyn

This is the same method as TrafficAssignment 109, but it uses dynamic segmentation which means volumes are assigned to partial links and locations are used internally, instead of nodes.

Output contains these fields:
1. Link ID
2. Start percent
3. End percent
4. Volume in forward direction
5. Volume in reverse direction

Syntax: TrafficAssignmentDyn(filename: string; GF: TGISformat 157; TL: TTrafficList 148; var Errors: TIntegerList 147)

2.8 TDrivingDirections

This class can be used for creating driving directions (turn left/right etc), but also simpler setups aimed at just mapping. Output goes to a TGISwrite[122] instance.

The 4 main methods:
Route[113], RouteList[113], RouteDyn[113] and RouteListDyn[113].

Route calculation properties

SortedIndex[114] allows you to visit the location in a different order than natural. Typically as a result from TTSP[139] / TTSPcurb[141] calculations.

RoundTrip[113] should be set, so it matches TTSP.mode[162] if used in combination with TTSP[139] / TTSPcurb[141].

OffRoadSpeed[112] can be used with RouteDyn and RouteListDyn, when coordinates are present in the LocationList.

SideInArray[114] and SideOutArray[114] can be used to define approach, when used in combination with TTSPcurb[141].
They can also be populated by calling CalcSideInOutArray[111], if sequence is known.

If underlying TRouteCalc.DuplicateLinks[102] is set, SideInArray and SideOutArray is ignored.

Output properties

The key property controlling the kind of output is ConcatenationMode[111].

These 7 properties control if each field should exist in the output or not:
Cost[111], Dist[112], Time[115], Speed[114] and DirectDist[111].
TotalCost[115], TotalDist[115] and TotalTime[115]

DirectDist, Dist and TotalDist are always possible, while Cost, Speed and Time require that the parent TRouteCalc[101] is set up correctly (see SetTime[93] and SetCost[92]).

DirectDist, Speed, cost and total cost are disabled by default. The rest are enabled.

These 3 properties control a possible time stamp field in the output:
StartTime[114], StopTime[115] and TimeStampFormat[115].

RoadFileID[112] is used for defining which road names should be used.

ViaList[116] is for including a textual description of the locations / nodes.

Driving directions properties

These properties are only relevant for mode cmDrivingDirections[155]:

POI[112]
RoundAboutCounting[113]
SharpTurn[113]
TurnText[116]

2.8.1 Create

When creating an instance of TDrivingDirections, it is required to specify a TRouteCalc instance.

Syntax: Create(Calc: TRouteCalc 101);

2.8.2 CalcDirectDist

This property contains the direct length of a route after calling RouteDyn 113 / RouteListDyn 113.
Unit is km or miles, according to DistanceUnit 112.

Type: TCost 156

2.8.3 CalcSideInOutArray

This method is for preparing SideInArray 114 and SideOutArray 114 with optimum values (avoiding U-turns as much as possible), when the elements in LL is already in the correct sequence.

It will test all possible combinations, so calculation time increases if LL has many elements or the elements are far apart.
As an example 100 locations takes 3 second, while 500 locations take 13 secs on the sample street network.

It should be used before calling RouteListDyn 113.

Syntax: CalcSideInOutArray(LL: TLocationList 147)

Only available in the Pro version.

2.8.4 ConcatenationMode

This key property controls the kind of output performed when calling one of the methods.

Default: cmDrivingDirections

Type: TConcatenationMode 155

2.8.5 Cost

This property controls if cost should be part of the output.

Default: false

Type: boolean

2.8.6 DirectDist

This property controls if directdist should be part of the output. Format of field is determined by DistanceUnit 112 and DecimalsDist 80.

Default: false

Type: boolean

2.8.7 Dist

This property controls if dist should be part of the output. Format of field is determined by DistanceUnit[112] and DecimalsDist[80].

Default: true

Type: boolean

2.8.8 DistanceUnit

When generating output, you can use this property to use miles & mph instead of km & km/h.

Default: duKm

Type: TDistanceUnit[156]

2.8.9 OffRoadSpeed

This property can be used to define the speed while moving from the exact coordinates (which are off road) to the nearest link.

It can only be used in combination with method RouteListDyn[113]. The LL parameter need to have both coordinates and locations defined internally. This is done by adding coordinates first and then use TSpatialSearch.NearestLocationSimpleList[76].

If it is 0 and ConcatenationMode = cmCompactOffRoad, it is the same as using cmCompact.

A typical value would be 5 km/h, for walking speed.

Default: 0

Type: TCost[156]

2.8.10 POI

It is possible to define a list of POI (Points-Of-Interest), that you want included in the output. For each link part of the result, it is checked if it contains any POI.

POI may be roadside signs, petrol stations etc. They are not possible during roundabouts.

Default: nil

Type: TPOIList[147]

2.8.11 RoadFileID

This property is used to describe which roadname[59] file is used for the driving directions.

If ConcatenationMode = cmDrivingDirections, it needs to be set.
If ConcatenationMode = cmSeparate, it can be set and shall then be included in the output.
For other modes, the roadname is not part of the output.

Default: 0

Type: integer

2.8.12 RoundAboutCounting

This property controls how exit links are counted as part of driving directions in roundabouts.

False: Only exit links are counted
True: All links are counted

Default: false

Type: boolean

2.8.13 RoundTrip

This property controls if the output should be generated as a round trip (A-B-C-A) or not (A-B-C).

If you call method Route 113 or RouteDyn 113 (2 points only), you may like to set it to false first.

Default: true

Type: boolean

2.8.14 Route

Same method as RouteList 113, just with 2 nodes and no need to setup a list of nodes.

Syntax: Route(output: TGISwrite 122; node1,node2: integer)

2.8.15 RouteDyn

Same method as RouteListDyn 113, just with 2 locations and no need to setup a list of locations.

Syntax: RouteDyn(output: TGISwrite 122; loc1,loc2: TLocation 158)

2.8.16 RouteList

This method calculates a route between all the nodes in NL and writes the result to output.

Syntax: RouteList(output: TGISwrite 122; NL: TIntegerList 147)

2.8.17 RouteListDyn

This method calculates a route between all the locations in LL and writes the result to output.

See also OffRoadSpeed 112.

Syntax: RouteListDyn(output: TGISwrite 122; LL: TLocationList 147)

2.8.18 SharpTurn

If this property is >0, it is possible to trigger a turn description in the output even when the street name doesn't change, but the road makes a clear turn at an intersection. Just define how sharp the turn should be. Suggested value is 60-75 degrees. This only applies to sharp turns at intersections - not halfway down a link.

Default: 0

Type: Integer

2.8.19 SideInArray

Set this property in combination with TTSPcurb 141 optimization, to control how locations are approached (in-bound).

Default: nil

Type: TApproachArray 154

Only available in the Pro version.

2.8.20 SideOutArray

Set this property in combination with TTSPcurb 141 optimization, to control how locations are approached (out-bound).

Default: nil

Type: TApproachArray 154

Only available in the Pro version.

2.8.21 SortedIndex

This property controls the order of the nodes / locations in the output. This is typically the output from TTSP.SortedIndex 141.

Alternatively you can setup your own TIntegerArray. It should be zero-indexed and contain all values from 0 to Count-1 only once, starting with 0.

Default: nil

Type: TIntegerArray 158

2.8.22 Speed

This property controls if speed should be part of the output. Format of field is determined by DistanceUnit 112.

Default: false

Type: boolean

2.8.23 StartTime

This property defines when time stamps start in the output and is defined as a fraction of a day.

Default: 0

Type: double 154

2.8.24 StopTime

This property defines when time stamps stops in the output and is defined as a fraction of a day. If StartTime 114 <> 0, it is ignored.

Default: 0

Type: double 154

2.8.25 Time

This property controls if time should be part of the output. Format of field is determined by DecimalsTime 80.

Default: true

Type: boolean

2.8.26 TimeStampFormat

This property controls the format for time stamp in the output. Works in connection with StartTime 30 and StopTime 115.

Default: tfSkip

Type: TTimeStampFormat 161

2.8.27 TotalCost

This property controls if total cost should be part of the output.

Default: false

Type: boolean

2.8.28 TotalDist

This property controls if total dist should be part of the output. Format of field is determined by DistanceUnit 112 and DecimalsDist 80.

Default: true

Type: boolean

2.8.29 TotalTime

This property controls if total time should be part of the output. Format of field is determined by DecimalsTime 80.

Default: true

Type: boolean

2.8.30 TurnText

If this property is defined an additional field is added to the output with textual description of the turns instead of just the values from 0 to 379.

Default: nil

Type: TTurnTexts 151

2.8.31 ViaList

This is for including textual descriptions and / or a fixed service time for each of the locations.

Default: nil

Type: TViaArray 162

2.9 TVoronoi

This class is used for generating Voronoi polygons and Delaunay triangulations. A detailed description of these can be seen in Wikipedia: Voronoi & Triangulation

The primary target is calculation of service areas and drivetime isochrones.

The sample application shows how to do it for isochrones and service areas. The other modes are done in a similar fashion.

You can also use the class independently from the routing functions, if you create and populate the PolyGeneration parameter on your own.

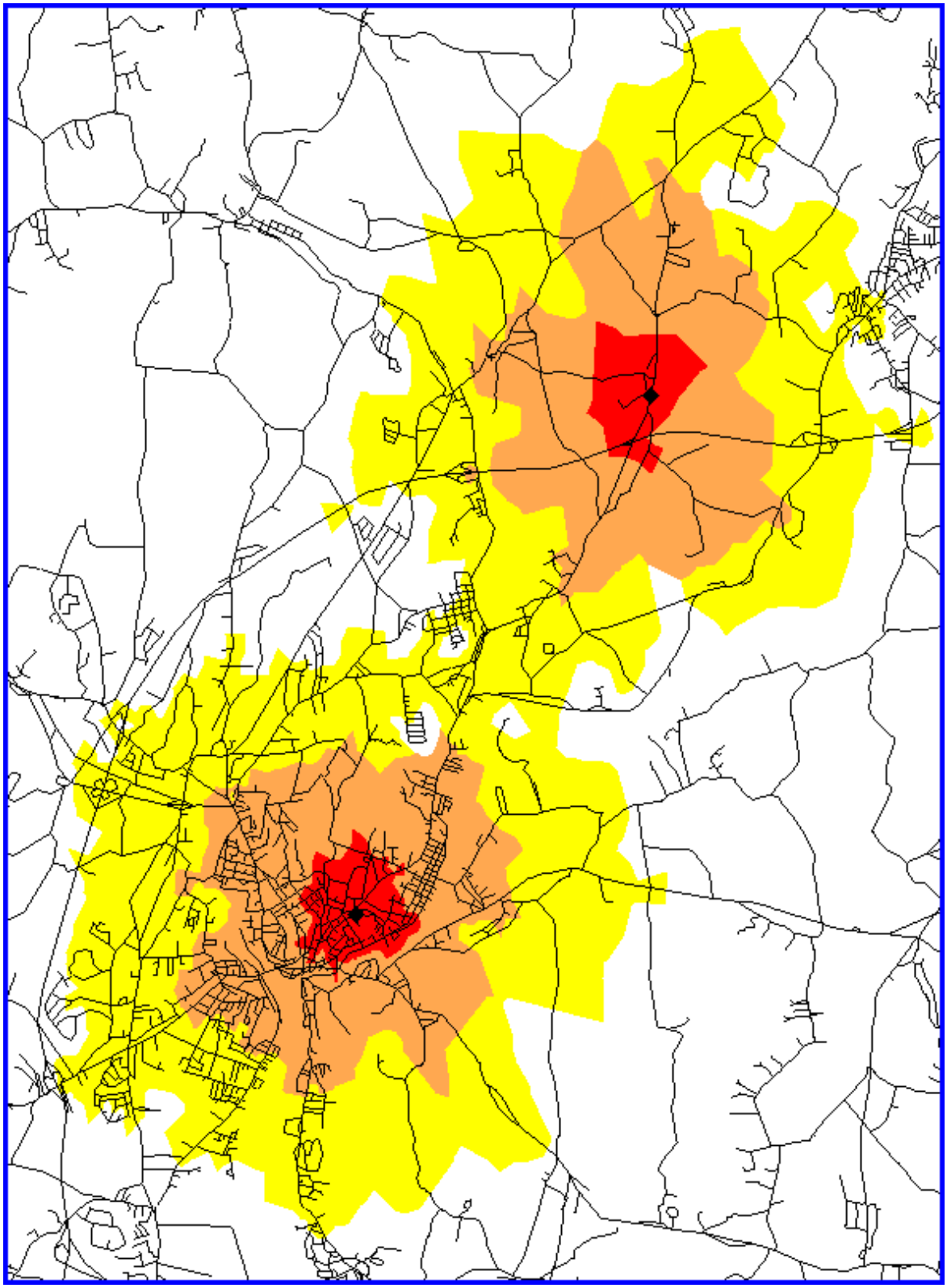
Properties relevant for each mode:

Mode	GISwrite 119	PolyGeneration 120	Slope 121	Zfieldname 121	Doughnut 118	ID 119	IncludeHoles 119	IncludeIslands 119	StepList 121	Smoothing 120
vmTriangulationLine	X	X	X	X						
vmTriangulationSimple	X	X	X	X						
vmSimpleLine	X	X								
vmSimple	X	X								
vmIsochrone	X	X			X		X	X	X	X
vmServiceArea	X	X				X	X	X		

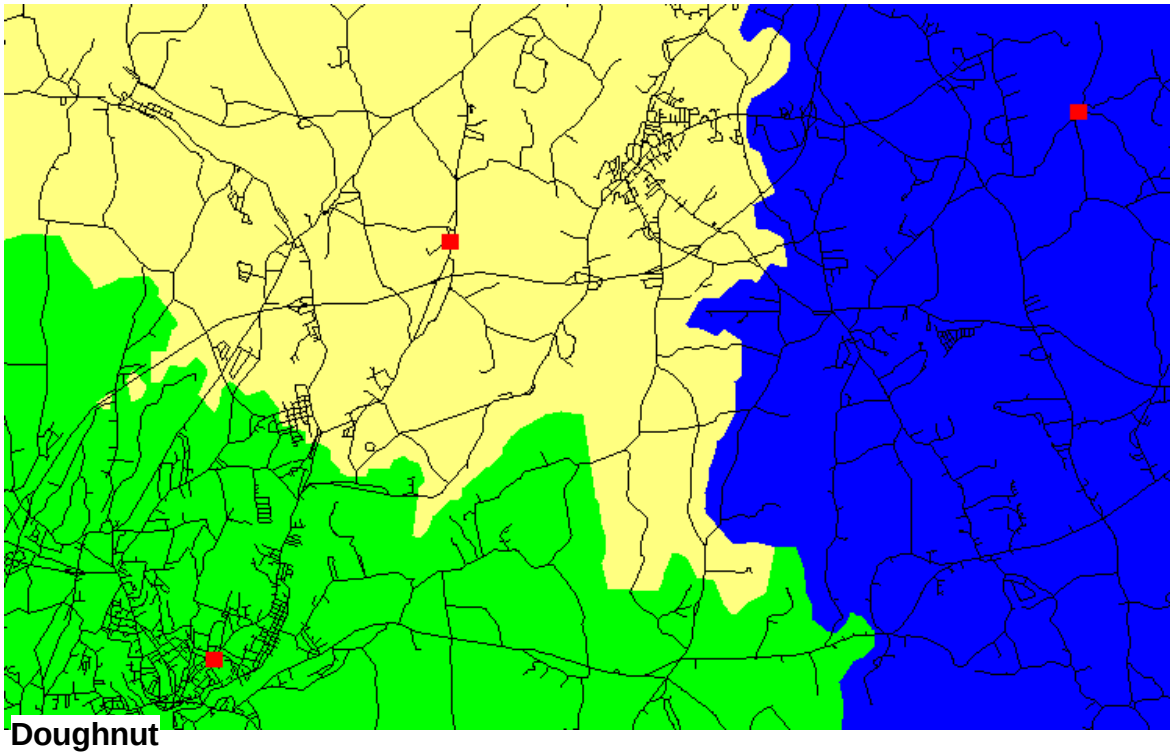
GISwrite, PolyGeneration and StepList need to be set.

Slope, Zfieldname, Doughnut, IncludeIslands and IncludeHoles have default values and can be left unchanged.

Example of drivetime isochrone:



Example of service area calculation:



2.9.1 Doughnut

This property controls if output is generated as doughnut when mode = vmIsoChrone.

Example: If StepList holds values 1, 2 and 3, you will get these 3 records in the output, depending upon the value:

false	true
0 - 1	0 - 1
0 - 2	1 - 2
0 - 3	2 - 3

Non-doughnut polygons (false) are overlapping.
Doughnut polygons (true) are not overlapping.

If true, IncludeHoles can not be false at the same time.

Default: true

Type: boolean

2.9.2 Execute

This is the main method for starting calculations.

Syntax: execute: integer

2.9.3 GISwriter

This is a reference to a TGISwriter instance, for holding output from the calculations.

Default: nil

Type: TGISwriter 122

2.9.4 ID

This property can be used in vmServiceArea mode to have an ID field, rather than the default 0,1,2... values.
The list need to contain as many elements as you have Startpoints in PolyGeneration 120.

Default: nil

Type: TStringList 151

2.9.5 IncludeHoles

This property controls if holes are allowed in the output, when mode 120 = vmIsoChrone or vmServiceArea.

These two maps, show the same 1 km isochrone with IncludeHoles = true and false:

Default: true

Type: boolean

2.9.6 IncludeIslands

This property controls if islands are included in the output, when mode 120 = vmIsoChrone or vmServiceArea.
It is an island if there is no center inside it.

Default: true

Type: boolean

2.9.7 MilesOutput

If you set this to true, cost values in PolyGeneration[120] and StepList[121] are assumed to be km. Output then gets written as Miles, dividing by 1.609.

Default: false

Type: boolean

2.9.8 Mode

This key property controls the kind of calculation and output performed when calling execute[118].

Default: vmIsoChrone

Type: TVoronoiMode[163]

2.9.9 PolyGeneration

This holds the main data used for the calculations.

Default: nil

Type: TPolyGeneration[149]

2.9.10 SetSmoothing

This method allows you to smooth the output when mode[120] = vmIsochrone. Call it before calling Execute[118].

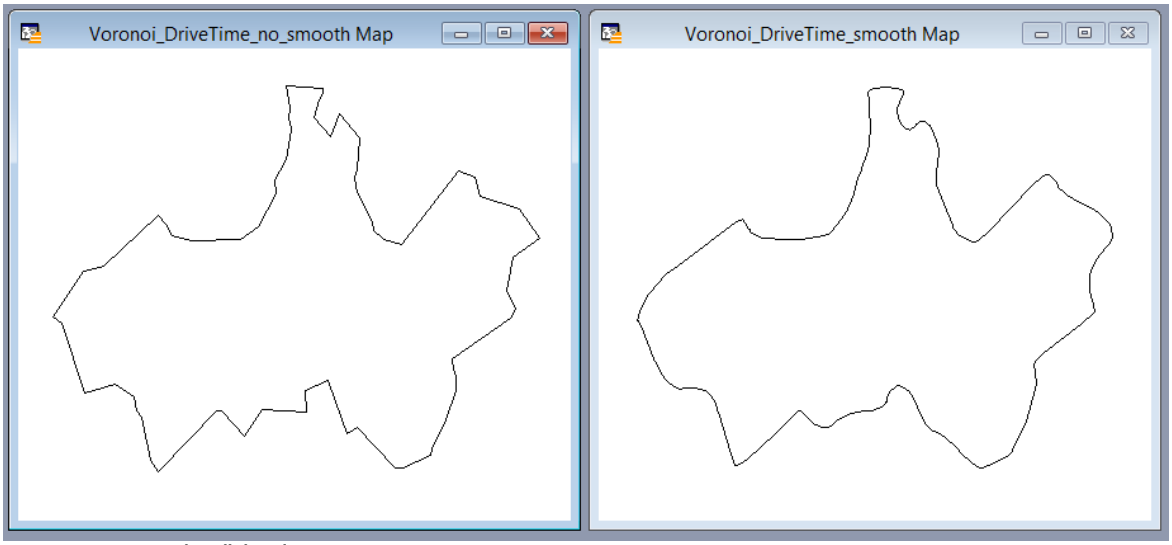
It is worth noting that the generated polygons do not get any more accurate, but may look more "visually" attractive on a map.

The number of nodes in the generated polygons will increase significantly, so use the function with care.

Recommendations:

- Call it with only 1 step[121]. With >= 2 steps there is a risk of unwanted overlaps.
- Leave doughnut[118] = false or you risk gaps between rings.

Example without and with settings (5,3,5):



Parameters and valid values:

Passes (1..5) defines how smoothed the output gets. A typical value is 3-4.

Rounded (3..6) defines how close the output fits the original input. 3 means any sharp angles almost disappear, while 5-6 for instance maintains the original look closer.

Deviation (0..15) allows you to remove some of the added nodes again to keep the total number of nodes lower without changing the look of the generated polygon too much.
Deviation is expressed in degrees. 1 degree will remove very few nodes, while 4-5 degrees will be good for most applications.

(0,0,0) is default value and means no smoothing at all. Use it for resetting.

Syntax: SetSmoothing(passes, rounded, deviation: integer; coord: TCoordinateUnit 155);

2.9.11 Slope

This is the slope of the triangulations. X, Y and Z (Cost) need to be in the same unit for it to work.

Default: false (which means not calculated in output)

Type: boolean

2.9.12 StepList

This property is used to define the steps used in mode vmIsoChrone. See Doughnut 118 too.

Default: nil

Type: TStepList 147

2.9.13 Zfieldname

Change this property if you want a different fieldname for the Z (cost) value. This is only relevant for the triangulation modes.

Default: "Cost"

Type: string

2.10 TGISwriter

This class is used for generating output from calculations. Typically as a GIS file with coordinates, but CSV and DBF files are also possible.

It is mostly used internally, but made available to users too. There is less error checking in this class, so you are to a higher degree responsible for what you are doing, if you use it directly. The sample uses it several times.

This table lists the 13 classes, which all has the same interface:

	Contains geographic data	Style information	File components	2 GB limit 127	Codepage
TGISwriterArray	X				Unicode
TGISwriterCSV			CSV		Ansi
TGISwriterDBF			DBF	X	Ansi
TGISwriterEFAL	X	X	TAB, MAP, ID, DAT	X	Ansi
TGISwriterEFALx	X	X	TAB, MAP, ID, DAT		Ansi / UTF8 / UTF16
TGISwriterGeoJSON	X		GEOJSON	X (if string)	UTF8
TGISwriterGML2	X		XML, XSD		UTF8
TGISwriterGPX	X		GPX		UTF8
TGISwriterKML2	X		KML		UTF8
TGISwriterMFAL	X	X	TAB, MAP, ID, DAT	X	Ansi
TGISwriterMIF	X	X	MIF, MID		Ansi
TGISwriterMIF8	X	X	MIF, MID		UTF8
TGISwriterMITAB	X	X	TAB, MAP, ID, DAT	X	Ansi
TGISwriterSHP	X		SHP, SHX, DBF, PRJ, CPG	X	Ansi

Despite most of the file formats can hold mixed object types 160 (SHP being the exception), we only support using a single object type.

Array
This is not file based opposed to the other formats. Not suited for very large datasets or you may hit an out-of-memory error.

CSV
This always uses , as field delimiter, no matter regional settings.
This always uses . as decimal point, no matter regional settings.
First line in the file contains the field names.

DBF
Stores codepage information in byte 29 in the header. This is standard, but not all software reads the information.

EFAL
This uses the EFAL library for writing TAB files.
EFAL can be downloaded from Precisely website.
Works with at least version 17 and 19.
Call TGISWriter.EFAL_Load(path) to load the library.

EFALx
The same as EFAL, except it writes NativeX format, readable with MapInfo 64-bit.

GeoJSON
If you don't specify a filename for output, the content is stored in a string property called GeoJSON instead.

GML2
2.1.2 format.

GPX
This only allows points and lines.
You should only use GPX if your coordinate system is already lat/long, WGS84.

KML2
2.2 format.
You should only use KML if your coordinate system is already lat/long, WGS84.

MFAL
Requires MIMFAL1500.DLL or MIMFAL1500_64.DLL on the path.
The generated table includes a spatial index and makes it slower to write than MITAB.

MIF
MapInfo-Interchange-File format

MIF8
The new UTF-8 formatted MIF file for MapInfo 15.2 (64-bit) and up.

MITAB
Requires MITAB.DLL or MITAB64.DLL on the path.
The generated table is generated without a spatial index. Pack the table in MapInfo to add this.
It can not generate NativeX tables.

SHP
CPG file is a simple text file with the codepage number. ArcGIS can read this information.

2.10.1 AddField

Call this method to add fields after creating the header 128.

Syntax: AddField(Fieldname: string; Field: TGISField 157; Width, decimals: byte)

SHP / DBF do not support field names with more than 10 characters.

Width should be specified for fChar and fDecimal.

Width is a maximum of 254 for fChar in DBF, EFAL, MIF, SHP and MITAB.
For GeoJSON, KML and GML there is no limit and width is ignored.

Decimals should be specified for fDecimal.

MITAB do not support gfInt64 as field.

2.10.2 Adding objects

There are 5 ways to add objects:

- AddPoint 124
- AddPoint2 125
- AddLine 125
- AddLine2 125
- AddObject 125 followed by AddSection 125 / AddSection2 126

In all methods the attributes for the object is added as a comma-delimited string.

Always use , as delimiter.
Always use . as decimal point.
Char fields with " inside, needs to have it escaped with "".

Number of elements in the string must match the number of fields, except for CSV and MIF where the content is written directly to the file.

When using gfChar fields, use Unicode and " around the text.
When using gfDate fields, use this format: YYYYMMDD
When using gfLogical fields, use this format for true: "T", "t", "Y", "y" or 1.
When using gfTime fields, use this format: HHMMSSsss (where sss = millisec, required !)
When using gfDateTime fields, use this format: YYYYMMDDHHMMSSsss (where sss = millisec, required !)

For SHP/DBF files, gfTime and gfDateTime are stored as text.
For TAB files, use of gfTime or gfDateTime means a version 9.00 file is generated.

Example:
A dataset consists of 9 fields, one of each type:
gfChar, gfInteger, gfSmallInt, gfDecimal, gfFloat, gfDate, gfLogical, gfTime, gfDateTime

Attribute string:
"test_text",1234567,123,123.45,123.45,19991231,1,123456000,19991231123456000

19991231123456000 = 31st of Dec 1999, 12:34:56.000

2.10.2.1 AddPoint

This adds a single point to the dataset.

Syntax: AddPoint(X, Y: double; Attrib: string)

2.10.2.2 AddPoint2

This adds a single point to the dataset.

Syntax: AddPoint2(P: TFloatPoint 157; Attrib: string)

2.10.2.3 AddLine

This adds a simple line to the dataset.

Syntax: AddLine(X1, Y1, X2, Y2: double; Attrib: string)

2.10.2.4 AddLine2

This adds a simple line to the dataset.

Syntax: AddLine2(P1, P2: TFloatPoint 157; Attrib: string)

2.10.2.5 AddObject

This adds the first part of a polyline / region object to the dataset.

Syntax: AddObject(NumParts: integer; MultiPolygon: boolean; Attrib: string)

After calling this method you should call AddSection 125 or AddSection2 126 as many times as stated in NumParts parameter.

If NumParts is 0, you will get an ungeocoded object in the dataset (works with point objects too). This is valid for all the formats, but we have seen some software not being able to deal correctly with SHP files with ungeocoded objects.

If you write to region output, have multiple outer rings and use GeoJSON, set MultiPolygon to true. For other situations, value do not matter.

NumParts can not be higher than 32000 for MIF and TAB formats.

2.10.2.6 AddSection

Call this method to add the actual coordinates in SegList:

Syntax: AddSection(Index: integer; var SegList: TFloatPointArrayEx 157)

For polyline datasets, the index parameter has no effect and you can just set it to 0.

For region / polygon objects it is important to store information about outer / inner rings (holes) correctly and different file formats has different requirements:

GML, KML, MITAB
Direction of coordinates: No requirements
Should be stored as first 1 outer and then N inner polygons.
This can be followed by further outer/inner sequences.
Index should be 0, 1, 2, 3 .... Change sign, if it is an outer polygon.

SHP
Direction of coordinates for outer polygons: Clockwise.
Direction of coordinates for inner polygons: Anti-clockwise.
Order of polygons and index parameter doesn't matter.

MIF and Array
No requirements

Common set of rules for all file formats
Direction of coordinates for outer polygons: Clockwise.
Direction of coordinates for inner polygons: Anti-clockwise.
Should be stored as first 1 outer and then N inner polygons.
This can be followed by further outer/inner sequences.
Index should be 0, 1, 2, 3 .... Change sign, if it is an outer polygon.
First and last coordinate should be the same for polygons or an error is raised.

2.10.2.7 AddSection2

Call this method to add a simple line object:

Syntax: AddSection2(Index: integer; X1, Y1, X2, Y2: double)

2.10.3 Brush

This property applies to regions in TAB / MIF output.

Default: BrushDefault 159

Type: TMIBrush 159

2.10.4 Close

Call this method to close the file, when you are done writing.

2.10.5 Codepage

This property describes the codepage used, when MIF, TAB, SHP, DBF and CSV files are generated.

EFALx, KML and GML always uses UTF-8.
Array format uses native Unicode.
If you use MIF as format and set codepage = 65001 (UTF-8), it is the same as choosing MIF8 as format.

Default: System default codepage.

Type: TCodePage 155

2.10.6 CompactMIF

This property describes if MIF files should be written in a compact form, without any object drawing styles (Brush 126, Pen 128 or Symbol 129).

Default: False (meaning style is included by default).

Type: boolean

2.10.7 Coordsys

This property is used when writing MIF and TAB files.

Default: CoordSys Earth Projection 1, 104 (Lat/Long, WGS84).

Type: String

2.10.8 Drop

This method will close and delete any generated files.

2.10.9 EFAL_Supported

This function returns true, if writing to TAB through EFAL is supported. This means if the EFAL library has been loaded.
Call EFAL_load() first with the path to the folder with EFAL.DLL.

Type: boolean

2.10.10 EPSG

The EPSG property should be set if you write to GML or GeoJSON.

Default: 4326 (Lat/Long, WGS84).

Type: Integer 154

2.10.11 Filename

Fill in this property for all file types, except Array format.

Type: String

2.10.12 FileIsFull

This read-only property returns true, if the file has reached 2 GB in size and you should not add more records.

For all other formats but SHP and TAB it always returns false.

Type: boolean

2.10.13 GeoJSON

When writing to GeoJSON format, this string contains the output.

Type: string

2.10.14 GISarray

When writing to array format, this object contains the output.

You should create the (empty) object first and then assign it to the TGA property.

Type: TGISarray 129

2.10.15 GreatCircleDist

This property should be set if your output is lat/long coordinates and you want to add additional nodes for every X km, so that the output is shown in your GIS application as great circles between start and end. A typical value could be 500 km, so this is only for very large objects.

It is the users responsibility only to use it with lat/long data or nonsense output may be generated.

Default value is 0.

Type: double 154

2.10.16 MITAB_Supported

This function returns true, if writing to TAB through MITAB is supported. This means if the library can find the relevant mitab.dll or mitab64.dll, depending upon the platform.

Type: boolean

2.10.17 OptimizePLinesSections

This property describes if consecutive matching polyline segment should be joined before output.

Default: False.

Type: boolean

2.10.18 Pen

This property applies to polylines and regions in TAB / MIF output.

Default: PenDefault 159

Type: TMIPen 159

2.10.19 PRJ

This property is used when writing the PRJ file in a SHP file collection.

Default:
GEOGCS["GCS_WGS_1984",DATUM["D_WGS_1984",SPHEROID["WGS_1984",6378137,298.257223563]],PRIMEM["Greenwich",0],UNIT["Degree",0.0174532925199433295]]

(Lat/Long, WGS84).

Type: String

2.10.20 StartHeader

Call this method when you are ready to create a new file.

As a minimum these properties should have been set in advance:
Array: TGA 127
CSV, DBF, KML2: Filename 127
GML2: Filename 127, EPSG 127

EFAL, MIF, MITAB: Filename 127, Coordsys 127
SHP: Filename 127, PRJ 128

Syntax: StartHeader(NumFields: integer; ObjectTypes: TObjectTypes 160)

After calling this method you should call AddField 123 as many times as stated in NumFields parameter.

2.10.21 Symbol

This property applies to style of points in TAB / MIF output.

Default: SymbolDefault 160

Type: TMISymbol 160

2.10.22 WrittenRecords

This read-only property keeps track of how many records has been written, since calling StartHeader 128.

If no records has been written after a process, you can safely call method Drop 127 to delete the empty files.

Type: integer 154

2.11 TGISarray

This class holds output information from TGISwriteArray.

The sample application shows how to iterate through the whole data structure.

2.11.1 OT

Information about the object type in the array.

Type: TObjectTypes 160

2.11.2 MBR

Minimum bounding rectangle for the whole array.

Type: TFloatRect 157

2.11.3 Field

This is a list of fields in the array.

Field: array of TFieldInfo 129

2.11.3.1 TFieldInfo

```
TFieldInfo = record
  FieldType: TGISField 157
  Width, decimals: byte
  Name: string
end
```

2.11.4 Rec

This is the actual data in the TGISarray

Rec: array of TRec 130

2.11.4.1 TRec

This is each record in the TGISarray:

```
TRec = record
  Attr: array of Variant (array of Object in .NET version)
  Coord: array of TFloatPointArray 157
end
```

Attr is the attribute information for the object. Length of array is the same as that of Field 129.

Coord is the lists of coordinates making up the object. Multiple lists are required for regions with holes for instance. See AddSection 125 for details.

2.11.5 RecCount

The number of records in the array. Rec 130 may have room for more records, since it is extended in size in steps.

Type: Integer 154

2.11.6 Clear

Call this method to clear all memory allocated.

Part III

Optimization classes

3 Optimization classes

Optimization classes are not part of all levels:

RW Net Standard & Pro:
TTSP 139

RW Net Pro
TOptimizer 132
TTSPcurb 141

3.1 TOptimizer

This class holds various optimization methods:

- Cluster1 133
This is when customers should be grouped into clusters of a uniform load. Minimizing geometric size of clusters.

- Cluster2 134
This is when customers should be grouped into a number of clusters. Minimizing total distance between cluster center and customers.

- Cluster3 135
This is when customers should be grouped into a number of clusters. Minimizing the maximum distance between cluster center and customers (minimax strategy).

- District 136
This is when customers should be assigned to existing centers with a capacity. Minimizing distance between centers and customers.

See also TCalc.CenterNode 96 to locate center of a single cluster.

3.1.1 Assignment

This property is read-only and holds the result of a calculation.

Property Assignment: TIntegerArray 158;

3.1.2 Capacity

This describes capacity of each center.

Property Capacity: TCostArray 156;

3.1.3 Center

This property is read-only and holds the result of a calculation.

Property Center: TIntegerArray 158;

3.1.4 Cluster1

This function solves the problem of clustering customers (with demands[136]), so load[138] within the cluster is lower than sCapacity and geometric size of cluster is minimized.

Cost is defined through a matrix[139], which can be calculated by TCalc.Matrix[87], TCalc.MatrixDyn[88], TNetwork.Matrix[56], TNetwork.MatrixDyn[56] or on your own.

Demand should be a much smaller number than sCapacity. Otherwise the algorithm isn't very good at finding a solution.

If Demand parameter is nil (not set), the algorithm assumes 1 for all customers. See also Swap[139].

The function returns number of clusters. Property Center[132] holds information about which customer is the center of the cluster.

Property	Dimension
Demand	No of customers
Matrix	No of customers x customers
Assignment (output)	No of customers
Center (output)	No of clusters
Load (output)	No of clusters

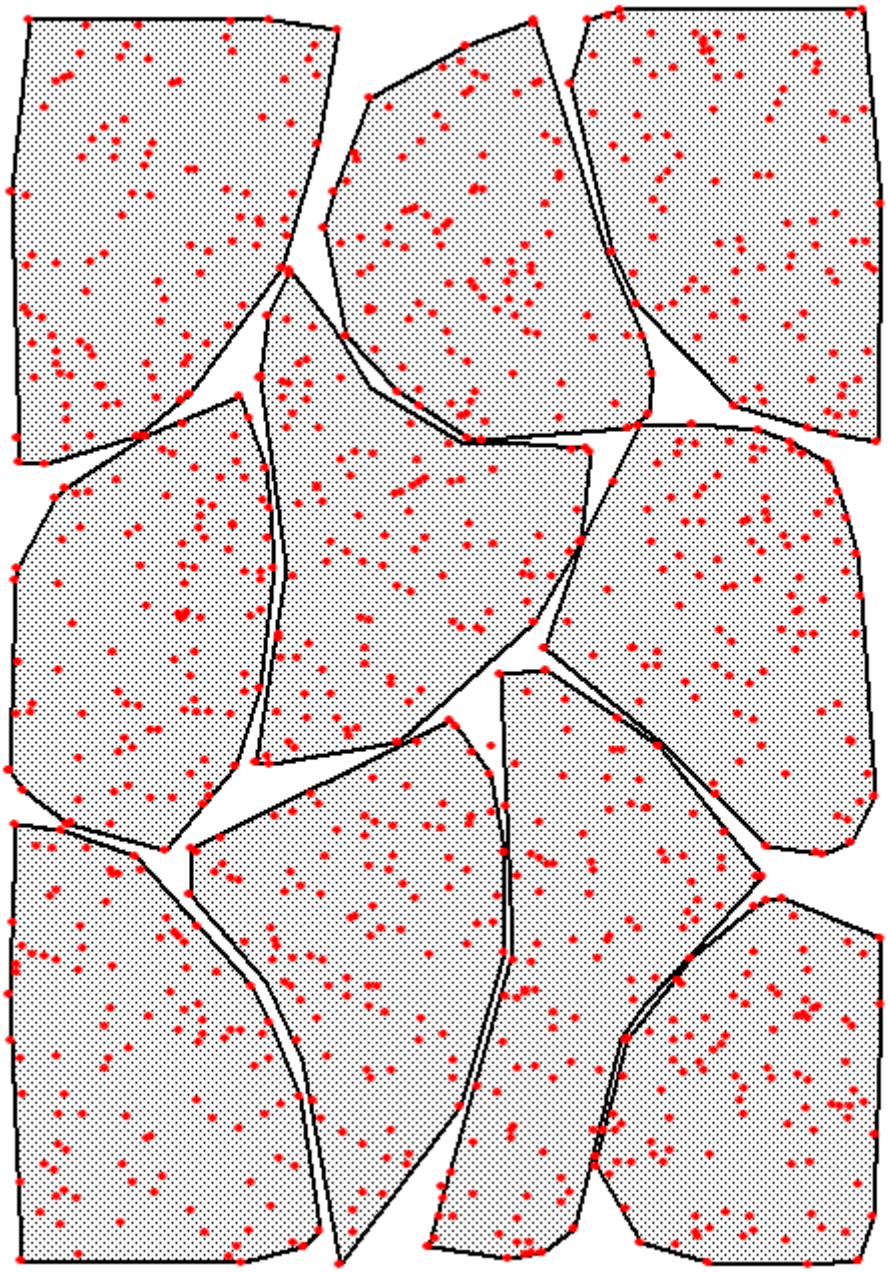
Sample calculation time (demand = 1 for all customers):

Customers	Clustersize	No of clusters	Calculation time (msec)
100	10	10	~0
1000	100	10	31
1000	10	100	250
10000	1000	10	2500
10000	100	100	22219 (22 sec)
10000	10	1000	219656 (~ 4 minutes)

With 50000 customers the matrix has reached a size of 10 GB - to give an indication of the largest instances that can be handled.
On win32 the limit is appr. 25000 customers.

Syntax: Cluster1(sCapacity: TCost): integer;

This is an example with 1000 customers and 10 clusters. Clusters are here highlighted as polygons:



3.1.5 Cluster2

This function solves the problem of clustering customers (with weights defined through demands[136] property), so total distance between cluster center and customers is minimized.

Cost is defined through a matrix[139], which can be calculated by TCalc.Matrix[87], TCalc.MatrixDyn[88], TNetwork.Matrix[56], TNetwork.MatrixDyn[56] or on your own.

If Demand parameter is nil (not set), the algorithm assumes 1 for all customers.

You can also call the function with NCluster = 1, if you just want to find the weighted center.

The function do not return any values, but populates these properties:

- Property Assignment[132] holds a number in the range 0 .. NCluster-1 about the cluster ID.
- Property Center[132] holds information about which customer is the center of the cluster.

Property	Dimension
Demand (used as weight)	No of customers
Matrix	No of customers x customers
Assignment (output)	No of customers
Center (output)	No of clusters

Sample calculation time:

Customers	No of clusters	Calculation time (msec)
100	10	32
1000	1	16
1000	10	47
1000	100	31
10000	10	3219
10000	100	3532
10000	1000	2422
20000	100	11891
20000	1000	8391

Syntax: Cluster2(NCluster: integer);

3.1.6 Cluster3

This function solves the problem of clustering customers, so maximum distance within each cluster between center and customers is minimized.

Cost is defined through a matrix[139], which can be calculated by TCalc.Matrix[87], TCalc.MatrixDyn[88], TNetwork.Matrix[56], TNetwork.MatrixDyn[56] or on your own.

You can also call the function with NCluster = 1.

The function do not return any values, but populates these properties:

- Property Assignment[132] holds a number in the range 0 .. NCluster-1 about the cluster ID.
- Property Center[132] holds information about which customer is the center of the cluster.

Property	Dimension
Matrix	No of customers x customers
Assignment (output)	No of customers
Center (output)	No of clusters

Sample calculation time:

Customers	No of clusters	Calculation time (msec)

100	10	~0
1000	1	16
1000	10	47
1000	100	31
10000	10	7031
10000	100	3968
10000	1000	3281
20000	100	19469
20000	1000	13750

Syntax: Cluster3(NCluster: integer);

3.1.7 Demand

This describes demand of each customer.

Property Demand: TCostArray 156;

3.1.8 District

This function solves the problem of assigning customers (with demands 136) to centers (with capacities 132), so
total load 138 is within the capacity and cost of travel is minimized for all customers.

Cost is defined through a matrix 139, which can be calculated by TCalc.Matrix2 87,
TCalc.MatrixDyn2 88 or on your own.

Normally you will have many more customers than centers.

Demand should be a much smaller number than capacity. Otherwise the algorithm isn't very good at finding a solution.

Optimum results can only be achieved if demand is the same value for all customers. Such as 1.

If Demand parameter is nil (not set), the algorithm assumes 1 for all customers.

The function returns the cost of the solution.

The heuristics parameter can take three values, 1, 2 and 3. With method 1 you will typically get the lowest
overall cost values, while method 2 gives "nicer" looking solutions, but requires more time to get the solution.
We recommend trying both and pick the result you prefer.

Method 3 give similar results as method 2, but requires demand=1 (or nil) for all customers. It is ~5 times faster.

Property	Dimension
Capacity	No of Centers
Demand	No of Customers
Matrix	No of Centers x Customers
Assignment (output)	No of Customers
Load (output)	No of Centers

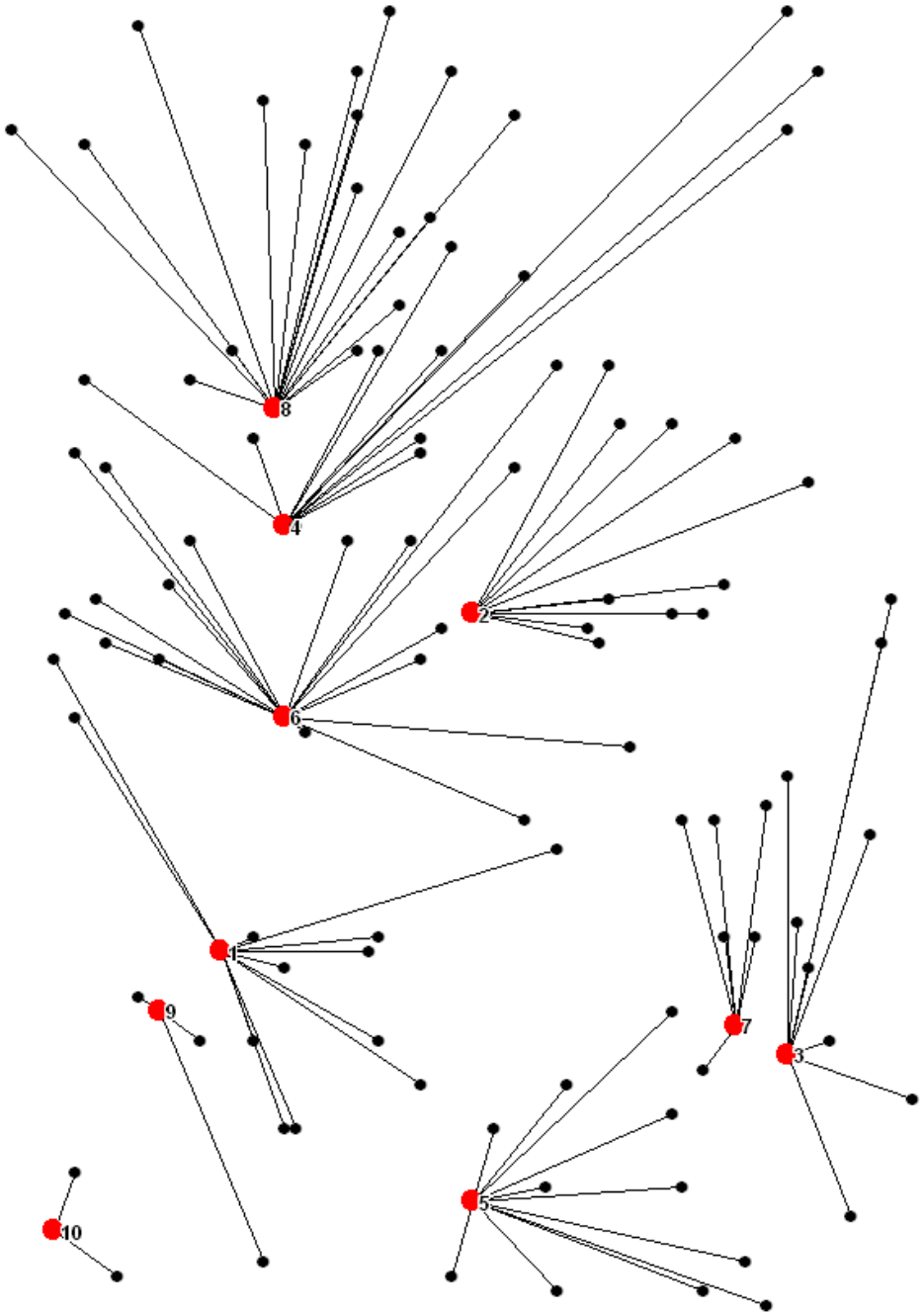
Unassigned	No of unassigned customers

Sample calculation time (demand = 1 for all customers, random center capacity, but sufficient in total):

Customers	No of centers	Calculation time - heuristic 1	Heuristic 2
100	10	16 ms	16 ms
1000	10	719 ms	734 ms
1000	100	1109 ms	860 ms
5000	10	220 sec (~ 4 minutes)	19 sec
5000	100	169 sec (~ 3 minutes)	240 sec (4 min)
5000	1000	15 sec	3754 sec (62 min)

Syntax: District(heuristic: integer): TCost 156;

This is an example with 100 customers, assigned to 10 centers with varying capacity. Customers and centers are connected with lines to make the result easier to view:



3.1.9 Load

This property is read-only and holds the result of a calculation, how much demand were assigned to each center.

Property Load: TCostArray 156;

3.1.10 Matrix

This is the input to the optimization, describing cost of matching centers and customers.

Property Matrix: TMatrix 159;

3.1.11 Swap

Set this to make the Cluster1 133 function perform additional steps of swapping and improving quality of solution a lot.
This makes it slower and should only be used with uniform demand 136.

Property Swap: boolean;

3.1.12 Unassigned

This property is read-only and reports how many customers wasn't assigned to a center in the District 136 method.

Property Unassigned: integer;

3.2 TTSP

This class is for travelling salesman optimization.

There is support for asymmetric matrices in the Pro version. This is especially important if you have many places in dense urban areas with many one-way restrictions.

In the Standard version, the input matrix is made symmetrical before optimization.

The algorithm uses random permutations, but you can control the randomness using the RandSeed 141 property.

Typically you will get the true optimum solution for instances with up to ~100 places to visit. With >100 places the quality of the solution degrades slowly.

Set properties PercentWithoutImproveStop 141, MinCalcTime 140 and TimeLimit 141 to control for how long time the optimization should continue.

Recommended values give a fairly good solution for up to 600 places.
With more places, increase the time values further.
With a faster CPU than 2013-standard, you can decrease the time.

Generally test how much time is really needed for your setup, if you are going to do similar calculations for the same area, many times.

Set Mode 141 before running the optimization 140.

It is also possible to monitor progress event 11, and eventually ask the algorithm to stop earlier.
When using PercentWithoutImproveStop 141, the progress may decrease when a new improvement is found.

After the optimization has finished, you have access to cost 140 and optimized sequence 141 (key result).

3.2.1 Cost

This read-only property holds the cost of the calculated sequence. It gets updated during execution too, if you monitor progress events 11.

Property Cost: TCost 156

3.2.2 Execute

This procedure starts the actual optimization.

Prepare the matrix using
- TNetwork.Matrix 56 or TNetwork.MatrixDyn 56 (for as-the-crow fly distances)
- TRouteCalc.Matrix 87 or TRouteCalc.MatrixDyn 88 (for real routes)

Eventually call MatrixPreProcess 140 to refine processing.

See also ExecuteFull 140.

Syntax: Execute(mat: TMatrix 159)

3.2.3 ExecuteFull

This works the same way as Execute 140, except it testes all possible combinations.

Calculation time increases fast as the dimension of the matrix increases. Just 10 elements means more than 3 million combinations (10!) and a calculation time of appr. 1 sec. With 12 elements you are reaching a couple of minutes.

Use it for testing if the solution found by Execute is the best possible. It almost always is with just 10 elements.

Syntax: ExecuteFull(mat: TMatrix 159)

3.2.4 MatrixPreProcess

Very often an optimization will result in some links being traversed more than once (either in the same or opposite directions). If there are multiple locations along that same link, it won't matter if the locations are visited first or second time the link is traversed. At least not from an optimization point of view. But for humans it feels most natural if all stops along the same link is just after each other.

This method will update the matrix, so short and long distances between locations are preferred to two medium distances. It essentially takes the square-root of the normalized cost: Matrix(*) = sqrt(Matrix(*) / max(Matrix(*))).

Example: Costs 0.25 + 0.75 has the same total as 0.5 + 0.5. After processing we will now see that sqrt(0.25) + sqrt(0.75) < sqrt(0.5) + sqrt(0.5), so 0.25 and 0.75 are preferred to 2x 0.5.

Syntax: MatrixPreProcess(var mat: TMatrix 159)

3.2.5 MinCalcTime

This property controls the minimum amount of msec, the optimization phase runs.

Recommended value: N * 50, where N = dimension of problem.

Default: 2000

Property MinCalcTime: integer

3.2.6 Mode

This describes how the optimization is performed.

Default value: tspRoundTrip

property Mode: TTSPmode 162

3.2.7 PercentWithoutImproveStop

This property controls when the optimization should stop.

If for instance the value is 50% and last improvement was after 20 sec, then it will stop after 30 sec, if no further improvements happened inbetween.
Assuming MinCalcTime 140 < 30 sec and TimeLimit 141 > 30 sec.

Default: 100.

Property PercentWithoutImproveStop: integer

3.2.8 RandSeed

This property controls which seed is used for the optimizations, so the same calculation can be run again, if needed. Or different one.

Default: 1

Property RandSeed: integer

3.2.9 SortedIndex

This read-only property holds the optimized sequence after calculation has ended.

Property SortedIndex: TIntegerArray 158

3.2.10 TimeLimit

This property controls the maximum amount of msec, the optimization phase runs.

Recommended value: N * 600, where N = dimension of problem.

Default: 10000

Property TimeLimit: integer

3.3 TTSPcurb

This class is similar to TTSP, except it also takes curb (kerb) approach and U-turns into consideration.

It shares these methods / properties with TTSP: Cost 140, MinCalcTime 140, Mode 141, PercentWithoutImproveStop 141, RandSeed 141, SortedIndex 141 and TimeLimit 141.

After the optimization has finished, you have access to cost[140], optimized sequence[141], SideIn[143] and SideOut[143].

Known issue:
Using this method with only 3 elements may not always give the optimium result. This shall be fixed.

See also CulDeSacCurb[106]

3.3.1 ExecuteCurb

This procedure starts the actual optimization.

Prepare the matrix using MatrixDynCurbIsochrone[107] or MatrixDynCurbRoute[107]

Eventually call MatrixPreProcess[142] to refine processing.

UTurnCosts should either be:
= 0: Allowed
> 0: Allowed, but at an additional cost
< 0: Turn not allowed.

To avoid U-turns, use a high cost or negative value.

DesiredSide:
See the sample on how to setup the array. It can basically be apIgnore or apReverse / apForward. The 2 last ones depend upon left / right driving.

Syntax: ExecuteCurb(mat: TCurbMatrix[156]; UTurnCosts: TCostArray[156]; DesiredSide: TApproachArray[154])

3.3.2 ExecuteCurbFull

This works the same way as ExecuteCurb[142], except it testes all possible combinations.

Calculation time increases fast as the dimension of the matrix increases. Just 10 elements means more than 3 million combinations (10!) and a calculation time of appr. 1 sec. With 12 elements you are reaching a couple of minutes.

Use it for testing if the solution found by Execute is the best possible. It almost always is with just 10 elements.

Syntax: ExecuteCurbFull(mat: TCurbMatrix[156]; UTurnCosts: TCostArray[156]; DesiredSide: TApproachArray[154])

3.3.3 MatrixPreProcess

Same method as TTSP.MatrixPreProcess[140], just with a different parameter.

Syntax: MatrixPreProcess(var mat: TCurbMatrix[156])

3.3.4 SideIn

This function returns from which side a location should be approached (in-bound).

Syntax: SideIn(index: integer): TApproach 154

3.3.5 SideInArray

This read-only property returns from which side all locations should be approached (in-bound). Can be used together with TDrivingDirections.SideInArray 114

Type: TApproachArray 154

3.3.6 SideOut

This function returns from which side a location should be approached (out-bound).

Syntax: SideOut(index: integer): TApproach 154

3.3.7 SideOutArray

This read-only property returns from which side all locations should be approached (out-bound). Can be used together with TDrivingDirections.SideOutArray 114

Type: TApproachArray 154

Part IV

Helper Classes

4 Helper Classes

These are classes that primarily are for input / output from the main classes.

4.1 TBaseList

Various generic lists are used throughout RW Net, see the sub-chapters for implementations:

TBaseList

This is a basic, unsorted list. T is the list item.

method Add(Item: T): Integer
method Clear
method Delete(Index: Integer)
method Extract(Index: Integer): T
method Insert(Index: Integer; Item: T)
property Capacity: Integer
property Count: Integer (read-only)
property Items[Index: Integer]: T

TBaseListSort adds these methods to TBaseList:

method IndexOf(Item: T): Integer
method RemoveDuplicates (calls Sort internally)
method Sort
property ReverseIndex: Boolean
property ReverseItems[Index: Integer]: integer (read-only)
property Sorted: Boolean (read-only)

4.1.1 TAltRouteList

This is an implementation of TBaseListSort 146

List item: TAltRoute 154

4.1.2 TCoordCostSiteList

This is an implementation of TBaseListSort 146

List item: TCoordCostSite 155

4.1.3 TGPSMatchList

This is an implementation of TBaseListSort 146

List item: TGPSMatch 158

4.1.4 TImportErrorList

This class is an implementation of TBaseList 146 with errors that gets recorded during data import 26 :

List item: TImportError 158

4.1.5 TIntegerList

This is an implementation of TBaseListSort 146

List item: integer

Adds two methods:

1) RemoveBlanks, which removes items that are 0.

2) SetFromBitArray, which creates a list of "true" elements in the TBitArray 148.

4.1.6 TIntegerLists

This is an implementation of TBaseListSort 146

List item: TIntegerList 147

4.1.7 TLocationList

This is an implementation of TBaseListSort 146.

This is a list of not just TLocations 158, but also a corresponding TFloatPoint 157. Depending upon how the list is being used, the requirements regarding the location and coordinate part may be different.

See also Location2CoordinateList 56 and NearestLocationSimpleList 76.

List item: TLocationListItem 158

Additional methods:
Add1(Item: TLocation 158): integer
Add2(link: integer; percent: TPercent 160): integer
Add3(P: TFloatPoint 157): integer
Add4(Item: TLocation 158; P: TFloatPoint 157): Integer
Add5(x,y: double): Integer
RemoveStartEndPos. Removes all items, where percent = 0 or percent = 1.

4.1.8 TPOIList

This is an implementation of TBaseListSort 146.

List item: TPOI 161

4.1.9 TStepList

This is an implementation of TBaseListSort 146

List item: TCost 156

Adds function Max, which returns the largest item.

4.1.10 TTrafficList

This class is an implementation of TBaseList 146 for use in traffic assignment 109.

List item: TTraffic 162

Only available in Pro

4.2 TBitArray

This class is simply an array of boolean values, but with additional functions built-in.

It is more or less similar to BitArray in .NET and TBits in VCL.

4.2.1 Bits

This property allows you to get or set individual bits in the array.

Property: Bits[Index: Integer]: Boolean

4.2.2 CountFalse

This method returns the number of false in the array.

Syntax: CountFalse: integer

4.2.3 CountTrue

This method returns the number of true's in the array.

Syntax: CountTrue: integer

4.2.4 P_And

This calculates logical *and* with the B parameter.

Syntax: P_And(B: TBitArray)

4.2.5 P_Not

This calculates logical *not* of the whole array. I.e. switches all values between false and true.

Syntax: P_Not

4.2.6 P_Or

This calculates logical *or* with the B parameter.

Syntax: P_Or(B: TBitArray)

4.2.7 SetAll

Sets all elements to the specified value

Syntax: SetAll(Value: boolean)

4.2.8 SetAllFalse

Sets all elements to false.

Syntax: SetAllFalse

4.2.9 SetAllTrue

Sets all elements to true.

Syntax: SetAllTrue

4.2.10 SetFromIntegerArray

This sets the size automatically and assigns to true, when the elements of IA is different from 0.

Syntax: SetFromIntegerArray(IA: TIntegerArray)

4.2.11 Size

This properties specifies the size of the array. If the array is extended, new elements are initialized to false.

Property Size: Integer

4.3 TPolyGeneration

This class is normally only used as a place holder for output from IsoPoly 85 / IsoPolyFast 86 method, which is used as input to TVoronoi 116.

IsoPoly 85 creates the instance, but you should free it on your own.

It can be exported using ExportPolyGeneration 50 for viewing of the content.

It contains 2 public fields, which can be accessed directly:

```
CoordCostSiteList: TCoordCostSiteList 146
StartPoints: TFloatPointArray 157
```

4.4 TRandom

This is for generating pseudo random numbers, but implemented as a class so you have full control and can use it in threads too.
It is also independant of the compiler used.

It uses the same formula as used in Delphi:
http://en.wikipedia.org/wiki/Linear_congruential_generator

4.4.1 NextDouble

Returns a number, 0 <= x < 1.

Syntax: NextDouble: double;

4.4.2 NextInt

Returns an integer, 0 <= x < value.

Syntax: NextInt(value: integer): integer;

4.4.3 Randomize

Initializes the random number generator from the compiler built-in random seed generator.

Syntax: Randomize;

4.4.4 SetSeed

Define your own seed, so you repeat a certain sequence of random numbers.

Syntax: SetSeed(value: Int64);

4.5 TRoadClassSpeed

This class is used for storing a set of speeds related to each road class 5.

It is a fixed array of doubles with index 0 to 31. Default value is 60 km/h. Only values >0 are allowed.

It can be accessed directly using its index.

It has a single method for loading from an INI file in the same format as used by FleetEngine and RouteWare Studio.
Default speed is 60 km/h for undefined classes.

If mph=true, all speeds are multiplied by 1.609 when read from the ini file.
Fractional speeds are allowed, always use . as decimal separator.

Syntax: LoadFromINI(filename, section: string: mph: boolean);

Example: LoadFromINI('c:\fleetengine.ini' , 'Net1');

[net1]
Speed1 = 110
Speed2 = 90
Speed3 = 71.5
etc.

4.6 TRoadClassTurnCost

Same as TRoadClassSpeed 150, except valid range is >=0 and default value is 0. Unit can be anything, but we recommend minutes.

Used in TurnAutoProcess 64.

4.7 TStringList

This parameter is slightly different, depending on the platform:

- .NET: List<string>
- Delphi: TStringList

4.8 TTurnTexts

This is a pre-populated array of strings, which you can use when generating driving directions 110.

All elements are accessible for reading / writing through property Items[], so you can modify them for your own liking.

Default values are in English.

Degrees	Text
0 - 22	Straight on
23 - 67	Slight turn to the left
68 - 112	Turn to the left
113 - 157	Sharp turn to the left
158 - 202	U-turn like
203 - 247	Sharp turn to the right
248 - 292	Turn to the right
293 - 337	Slight turn to the right
338 - 360	Straight on
361	Take exit 1 from roundabout
362	Take exit 2 from roundabout
363	Take exit 3 from roundabout
..	..
379	Take exit 19 from roundabout

Part V

Simple types

5 Simple types

These types are the simple ones, without a constructor / destructor.

5.1 Single

A single is a 4-byte floating point number. It is generally used for costs, distances etc. in RW Net.

5.2 Double

A double is a 8-byte floating point number. It is generally used for coordinates.

5.3 Word

Word means a 2-byte unsigned integer (uint16).
Range: 0 to 65,535.

5.4 Integer

Integer means a 4-byte signed integer (int32).
Range –2,147,483,648 to 2,147,483,647.

5.5 Int64

Int64 means a 8-byte signed integer.
Range: –9,223,372,036,854,775,808 to 9,223,372,036,854,775,807.

This is typically used when working with unique identifiers in databases like TomTom, HERE and OpenStreetMap.

5.6 TAltRoute

A TAltRoute record is a single route as a result of multiple alternative routes, see TRouteCalc.AltRouteDyn 105

```
TAltRoute = record
  Route: TRoute 161
  distance,time,sortvar: TCost;
end
```

5.7 TApproach

Enumeration: (apIgnore, apForward, apReverse)

5.8 TApproachArray

Array of TApproach 154

5.9 TCodePage

On .NET: Same as System.Text.Encoding

On other platforms: Word 154

See also Wikipedia

5.10 TColor

Same as integer 154 on .NET

5.11 TConcatenationMode

This enumeration describes the various modes for TDrivingDirections 110 output:

cmVeryCompact	The whole result as one record
cmCompact	All segments between two locations as one record
cmCompactOffRoad	As above, but with off road segments separately
cmDrivingDirections	As driving directions
cmSeparate	With all segments as separate records - very detailed and includes link ID

5.12 TCoordCostSite

This type is used as input to voronoi generation.

```
TCoordCostSite = record
                   Cost: TCost 156
                   Site: Integer 154
                   P: TFloatPoint 157
                 end;
```

If site = 65535 it means no nearest facility was in reach.

5.13 TCoordinateUnit

This enumeration informs about the coordinate units in use. It can only be set before importing 26 a dataset.

Geographic coordinates:
cuRad (radians, -pi - +pi, -pi/2 - +pi/2)
cuDeg (degrees, -180 - +180, -90 - +90)
cuGrad (grads, -200 - +200, -100 - +100)

Projected coordinates (SI units):
cuMm
cuCm
cuDm
cuM
cuKm

Projected coordinates (non-SI units):
cuPoint

cuInch
cuLink
cuFt
cuSurveyft
cuYard
cuChain
cuRod
cuMiles
cuNmi
cuUnknown

Data using geographic coordinates are checked during import for valid range.

By far the most usual ones are cuDeg and cuM.

5.14 TCost

This is used for cost, time, turn delays and speed of routes, links etc.

Alias for Single 154

5.15 TCostArray

Array of TCost 156

5.16 TCurbMatrix

A 3D array of TCost 156 elements.

See TTSPCurb 141 and MatrixDynCurbRoute 107 / MatrixDynCurbIsochrone 107.

5.17 TDistanceUnit

Enumeration: (duKm,duMiles)

5.18 TErrorCode

An enumeration:

ecDeleted	Object is deleted
ecNotGeoCoded	Object is not geocoded
ecNotPolyLine	Object is not a (poly)line, but type <value> (value only for SHP/TAB file)
ecMultiSection	Object has <value> sections
ecZeroOrOneVertices	Object has only <value> vertices
ecLoopLink	Object is a loop link
ecTooManyVertices	Object has >65535 vertices

Not all error codes are possible for both TAB, MIF and SHP files.

5.19 TFileKind

Enumeration: fkCSV, fkDBF

Use fkCSV when working with comma-separated files, such as CSV and MIF
Use fkDBF when working with DBF and DAT files.

5.20 TFloatPoint

This is a record describing a point:

```
TFloatPoint = record
  x,y: double 154
end
```

If you are working with spherical / geographic coordinates, use x for longitude and y for latitude.

5.21 TFloatPointArray

Array of TFloatPoint 157

5.22 TFloatPointArrayEx

```
TFloatPointArrayEx = record
  Pnt: TFloatPointArray 157
  Count: Integer
end
```

Count keeps track of how many positions in Pnt is in use.

5.23 TFloatRect

This is a record describing a rectangle:

```
TFloatRect = record
  xmin,ymin,xmax,ymax: double 154
end
```

5.24 TGISField

Field type identifier:

Enumeration: (gfChar, gfInteger, gfSmallInt, gfDecimal, gfFloat, gfDate, gfLogical, gfTime, gfDateTime, gfInt64)

5.25 TGISFormat

GIS format identifier:

Enumeration: (gfMIF, gfDBF, gfSHP, gfCSV, gfArray, gfMITAB, gfGML2, gfKML2, gfGeoJSON, gfMFAL, gfMIF8, gfEFAL, gfEFALx, gfGPX)

gfMFAL is not available for .NET.

Output from gfGeoJSON is stored as a string on the calling object, if no filename is specified:

TNetwork.GeoJSON 53
TSpatialSearch.GeoJSON 75
TCalc.GeoJSON 81
TGISwriter.GeoJSON 127

5.26 TGPSMatch

This record type is used for storing results for possible matches from function TSpatialSearch.NearestLink 75

```
TGPSMatch = record
  Loc: TLocation 158
  Distance: double
  DifBearing: double
  Reverse: boolean
  OneWayMisMatch: boolean
end;
```

Distance is in km. The smaller, the better
DifBearing is in degrees. The smaller, the better.
Reverse: True, if the record is for driving in the opposite direction of digitization.
OneWayMisMatch: True, if the road is oneway and it doesn't match the bearing.

5.27 TImportError

```
TImportError = record
  fileindex: integer, 0-based, refers to items in list of files 27
  linklocal: integer, 1-based, refers to a link inside a file
  link: integer, 1-based, refers to total sequence of links (internal ID)
  errorcode: TErrorCode 156
  value: integer
end
```

5.28 TIntegerArray

Array of integer 154

5.29 TLocation

See network terminology 4 for details.

```
TLocation = record
  link: integer
  percent: TPercent 160
end
```

5.30 TLocationListItem

```
TLocationListItem = record
  loc: TLocation 158
  P: TFloatPoint 157
end
```

5.31 TMatrix

A 2D array of TCost 156 elements.

When used in optimizations it need to be square.

5.32 TMIBrush

This is used for defining region style in TAB / MIF files.

```
TMIBrush = record
  pattern: TMIBrushPattern 159
  fg_color : TColor 155 (foreground)
  bg_color : TColor 155 (background)
end
```

Predefined TMIBrush constants:

```
BrushDefault: Black outline, white fill
OutlineOnly: Black outline, no fill
```

5.33 TMIBrushPattern

This describes a MapInfo pattern from 1 to 71. How they look can be seen in MapInfo's documentation.

Type: Integer 154

5.34 TMILinePattern

This describes a MapInfo line pattern from 1 to 118. How they look can be seen in MapInfo's documentation.

Type: Integer 154

5.35 TMIPen

This is used for defining polyline and region linestyle in TAB / MIF files.

```
TMIPen = record
  Width: TMIPenWidth 160
  pattern: TMILinePattern 159
  Color: TColor 155
end
```

Predefined TMIPen constants:

PenDefault: Solid narrow line
PenInvisible: Invisible line (used by regions)

5.36 TMIPenWidth

This describes a MapInfo line width from 1 to 2047. See MapInfo's documentation for further documentation.

Type: Integer 154

5.37 TMISymbol

This is used for defining polyline and region linestyle in TAB / MIF files.

```
TMISymbol = record
  Shape: TMISymbolNo 160
  Color: TColor 155
  Size: TMISymbolSize 160
end
```

Predefined TMISymbol constant:

SymbolDefault: Small black dot

5.38 TMISymbolNo

This describes a MapInfo symbol style from 31 to 67. How they look can be seen in MapInfo's documentation.

Type: Integer 154

5.39 TMISymbolSize

This describes a MapInfo symbol size from 1 to 48. See MapInfo's documentation for further documentation.

Type: Integer 154

5.40 TObjectTypes

Enumeration:

otNone	No object
otPoint	Point
otPline	Polyline
otRegion	Region / Polygon

5.41 TPercent

See network terminology 4 for details.

Alias for double 154

5.42 TPOI

TPOI is used for "Points-Of-Interest" that can be included in driving directions 110. Name and location fields should be self-explanatory, while approach parameter can be used, if a POI can only be seen when driving in one direction.

If you know the coordinates of a POI, use TSpatialSearch.NearestLocation 75 to get both location and side of road.

This table shows how to translate from side to approach, if we assume a POI is only visible in the same side of the road as the vehicle is moving:

Side	Right-hand driving	Left-hand driving
-1 (left)	apReverse	apForward
+1 (right)	apForward	apReverse

If a POI is visible when driving in both directions, just set Approach to apIgnore.

```
TPOI = record
  Name: string
  Location: TLocation 158
  Approach: TApproach 154
end
```

5.43 TRoute

A TRoute describes a sequence of links and nodes, together making up a route between 2 nodes or 2 locations:

If there are one less links than nodes: Between 2 nodes (and percent1=percent2=0)
If there are one less nodes than links: Between 2 locations

```
TRoute = record
  nodes: TIntegerArray 158
  links: TIntegerArray 158
  percent1,percent2: TPercent 160
end
```

If a link number is negative it is travelled in the reverse direction.

5.44 TTimeStampFormat

This enumeration describes the format for time stamps in TDrivingDirections 110:

tfSkip	Skip in output
tf24hour	24 hour format: "23:59"
tf12hour	am/pm format: "11:59 PM"
tfFloat	Floating point number for your own formatting (fraction of a day). It may be >1, but not negative. Example: 0.25 = "6:00 AM" = "6:00"
tfString	A string in the same format as TCalc.TimeFormatAsString 95

5.45 TTraffic

This type is used for a volume of traffic between coordinates P1 and P2 in traffic assignment 109.

```
TTraffic = record
  P1,P2: TFloatPoint 157
  Volume: TVolume 162
end
```

Only available in Pro

5.46 TTSPmode

This enumeration describes the various modes for TSP optimization:

tspRoundTrip	This is the classic round trip mode
tspStartEnd	This starts at the first item in the list and ends at the last item
tspOpenEnd	This starts at the first item, but can end at any item
tspOpenStart	This can start anywhere, but ends at the list item
tspOpen	This can start and end anywhere

When optimizing for all other modes but tspRoundTrip, set extra = true in methods Matrix 56 and MatrixDyn 56.

5.47 TVertexCount

This is used for the number of vertices on a link.
Minimum is 2 (first and last).
Maximum is 65535.
It is the same as a 2-byte unsigned integer (word 154).

5.48 TVia

This type and corresponding TViaArray 162 can be used when creating driving directions 110.

Field *name* is a textual description and *time* is the time in minutes it takes to make the stop.

```
TVia = record
  Name: string
  Time: TCost
end
```

5.49 TViaArray

array of TVia 162

5.50 TVolume

This is used in traffic volumes in TTraffic for traffic assignments 109.

Alias for single 154

Only available in Pro

5.51 TVoronoiMode

This enumeration describes the various modes for voronoi 116 output:

vmTriangulationLine	Basic triangulation, as line output
vmTriangulationSimple	Basic triangulation, as polygon output
vmSimpleLine	Basic voronoi, as line output
vmSimple	Basic voronoi, as polygon output
vmIsochrone	Drivetime isochrone
vmServiceArea	Service area

5.52 TWordArray

Array of Word 154