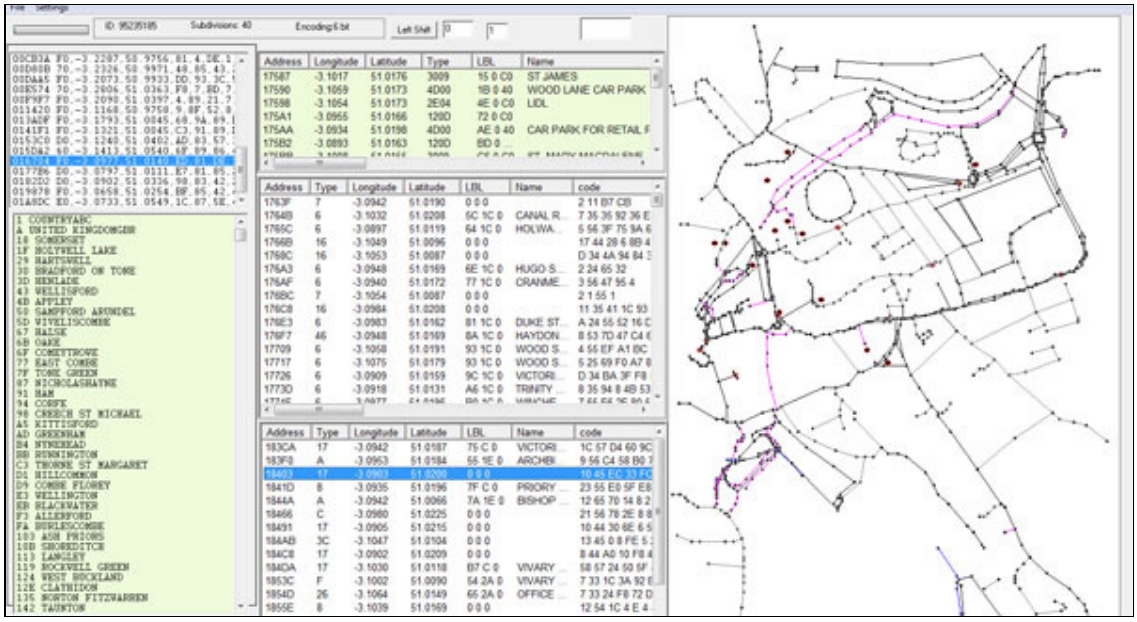
Exploring Garmin's IMG Format

TRE , RGN, LBL, NET, NOD & DEM



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If you downloaded the manual from another source it will not be up to date.

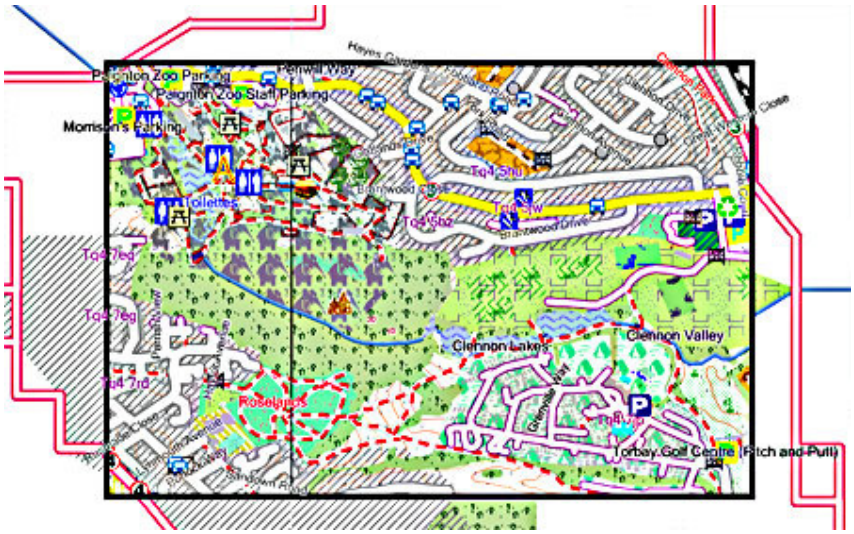
more information on www.pinns.co.uk/osm/garmin.html

Latest Revision 02/03/2015

TDB Editor 1.1

Download & checkout the only tdb editor to:

- *lock & unlock your Mapsource/Basecamp maps.*
- *restore Mapsource when it crashes*
- *rename any mapsource/basecamp name*
- *change mapnames so they are easier to read on your gps*
- *Lock & Unlock your own maps*
- *add/remove routable option*
- *force direct routing when it doesn't work*
- *add/remove profile option.*
- *add or edit copyright description when creating your own maps*
- *create or remove 'Reduced map window for printing' and other (printing or viewing) messages*
- *disable any form of printing.*
- *add or resize Restricted Window View*
- *quickly identify & edit mapnames, useful when you want to isolate a particular IMG file.*



Introduction

For anyone who wants to delve more deeply into the IMG structure John Mechalas (JM)‘ ‘Garmins IMG File Format’ is a must read. We all owe a great deal to the author of cgpsmapper without whom the booklet could not have existed.

Apart from this excellent document there seems to be nothing else available. Unfortunately, there are some crucial errors in the JM’s description, making it more even more challenging.

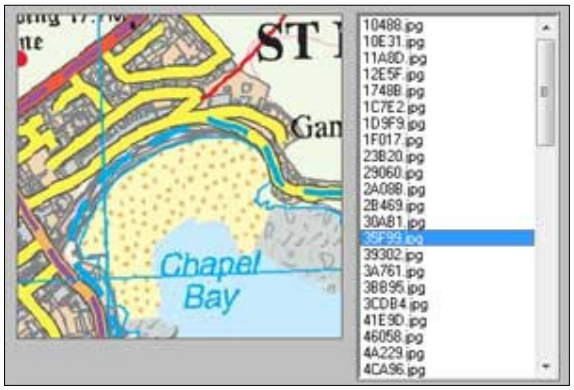
Our aim is to tie up some loose ends and use frequent examples to make the format more accessible. However, the IMG structure may to some still be a steep learning curve.

In this ongoing document I intend to focus on how to access and plot poi, polyline and polygon data within an IMG file. From the picture in the title you can see that, my humble efforts after 3 years of frustration, have finally been successful. There were many occasions when I felt like giving up as I was getting nowhere really fast.

IMG Explorer shows pointers and coordinates held in an IMG file and can be downloaded on request only.

We would welcome any additional information or queries using email address found at : *www.pinns.co.uk/osm/*

Garmin NT



At present this document does not address Garmin’s new NT format – more information about this subfile can be found at openstreetmap GMP wiki . Suffice it to say, the img structure of pointers is not much different and the offsets are calculated differently. With active routing additional information is attached to each line. Its routing compaction is also more efficient.

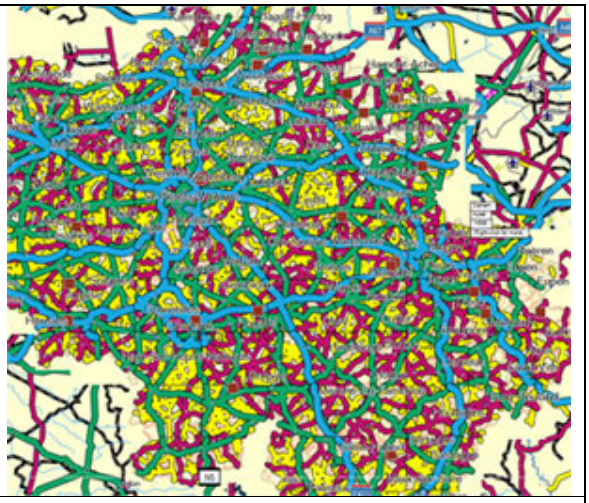
NT caters for postcode searches and routing using multiple highway lanes.
For this reason, there doesn't appear to be a viable incentive to reverse engineer this format.

IMG Explorer can ,however, extract all tiles contained in the file and gives the starting address for each tile. The LBL contains the ref names of tiles followed by pointers to each tile taken from the end of lbl1,

IMG2TYP

I've written this GUI to read IMG files and list all element types found in TRE so that they can be saved as a TYP file. Check out on youtube

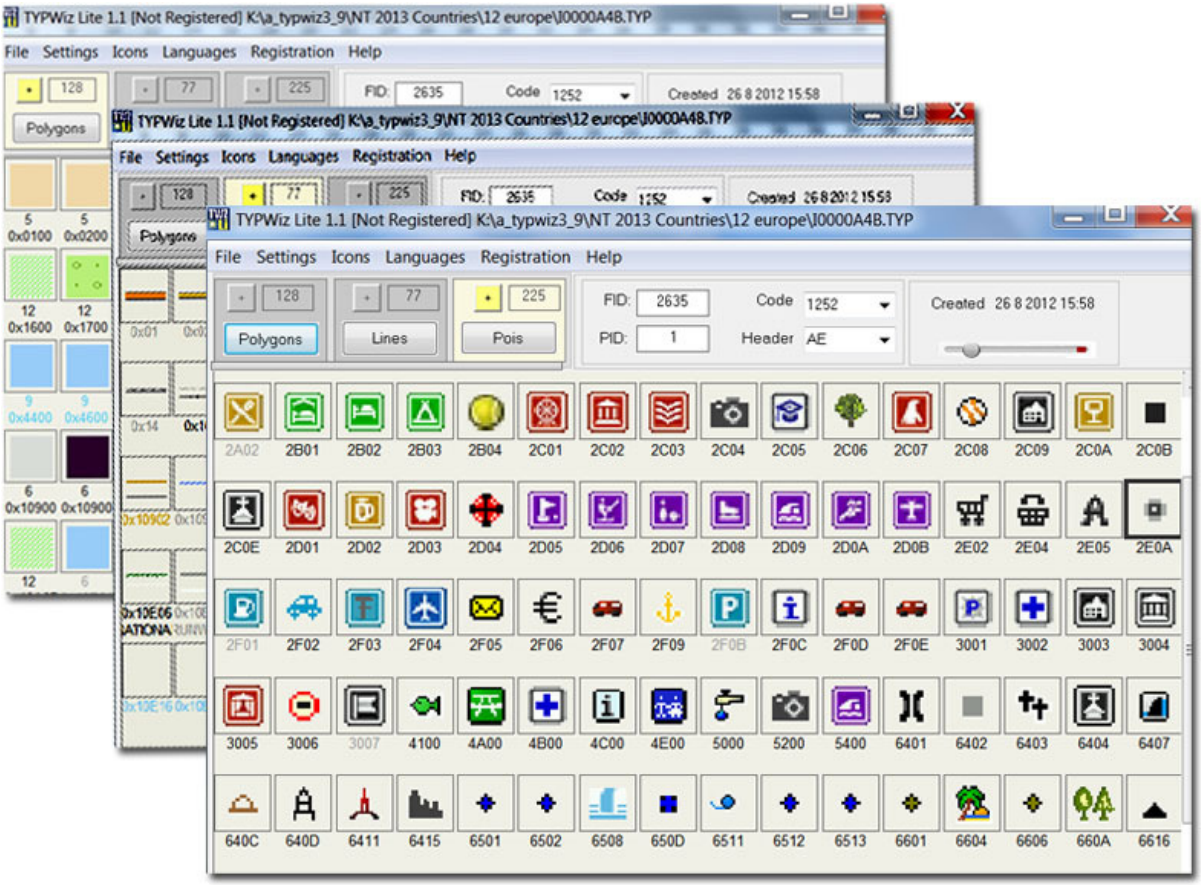
before



after

TYPWiz

Use TYPWiz in connection with img2typ and you are well on your way to changing the rather drab TYP files which accompany CN 2012-2015 maps ! Check out on Youtube



Garmin headers

An IMG file consists of several blocks, or sub files, each doing a specific job:

TRE, RGN, LBL , NET , NOD

The one we're particularly interested in is the RGN subfile as we want to establish how all highways, polygons and points of interests are plotted.

RGN header

In the RGN subfile we find the essential data for plotting our elements: coordinates, ,length of highways, number of sides in each polygon etc. The header looks like this:

RGN Offset	RGN Header	BYTES
00	Header Length	
02	GARMIN RGN	4
15	Pointer to beginning of RGN1 data, ie first subdivision to include possible POIs,Indexed POIs,Polylines or Polygons or first map level	4
19	Length of this block	4
1D	Pointer to RGN2 data block,contains **extended** polygons with types 0 x 100+ ; for undocumented details about its structure see further	4
21	Length of this block	4
39	Pointer to RGN3 data block ; this block contains **extended** polylines with types 0 x 100+ ; for undocumented details about its structure see further	4
3D	Length of this block	4
55	Pointer to RGN4 block containing **extended** POIs ; for undocumented details about its structure see further	4
59	Length of this block	4
65	FF	
66	3F (7F) (o3)	
67	0	
68	20 3f f7 ff 3f	4
6D		4
75	Block or length	4
79	0x E3 (E5)3f	

How are all the elements (pois,polylines and polygons) stored?

You could imagine that, as maps rely on individual nodes, pois are plotted first, followed by the polygons etc. Yes and no. To understand how they are stored we need to look at :

1) maplevels

2) subdivisions.

Map levels

To save space, Garmin opted for a unique solution using maplevels and subdivisions.

To enable any kind of zooming, Garmin has decided to plot data in 'zoom chunks'; the deeper the zoom the more information it contains, ie the more highways etc are plotted.

At the lowest zoom, very few pois, if any and only a few highways are plotted - each created using only a limited number of nodes,thus making them look straighter and more ragged .

These zoom levels are called maplevels ,each with subdivisions.

Maplevel 1	Subdivision
	Subdivision
Maplevel 2	Subdivision
	Subdivision
	Subdivision
Maplevel 3	Subdivision

Regard map levels as *groups* of subdivisions .

Each map level is given a separate data block telling you:

1) what elements to plot

2) at what resolution /degrees of accuracy

3) how many subdivisions it has grouped together – sometimes none!

Subdivisions

Before we retrieve these maplevel blocks, let's explore the nitty gritty of sublevels.
Each subdivision contains data visible at that level. Some subdivisions can share data with others.
The main highways are often plotted at different zoom levels and hence at a different resolution/ accuracy, whereas hardly any pois are plotted at the lowest level when you zoom out.
So there is a certain amount of doubling up, despite Garmin's main aim to reduce its IMG file size.

How are these subdivisions constructed?

Consider the following:

1) POIs don't need as much data as highways; in fact they only need one node
2) Not all highways are the same length
3) Polygons are not the same shape and their number of nodes can vary too.

Unfortunately, because the pois and highways data are not the same lengths, we need to know where the starting points are for each element data block .

Ideal situation : every object the same length:

Poi 1										
Poi 2										
Polyline 1										
Polyline 2										
Polygon 1										
Polygon 2										

Garmin's approach:

Poi 1				**Poi 2**				**Polyline1**		
							Polyline2			
										Polygon1
Polygon2										

You could not have the 'ideal' situation unless you limit the number of nodes for each highway or polygon to say 1000. That would be such a waste if the lines are short etc.

Note :The maximum length of a subdivision is finite – the exact length is not clear - , hence the existence of numerous subdivisions depending on the amount of data within a maplevel.

Pointers in a subdivision

As a compromise, Garmin decided to plot all pois in a subdivision in one chunk, followed by highways, followed by polygons.

To make sure we know where each element chuck starts we need to be given some **pointers**. These pointers are not saved somewhere else but are given just before the start of a chunk. More specifically, *all pointers are given before the first chunk appears, at the beginning of each subdivision and are 2 bytes long* :

Pointer to chunk2	Pointer to chunk 3	Chunk 1	Chunk 2	Chunk 3

You would expect:

Pointer to chunk1	Pointer to chunk 2	Pointer to chunk 3	Chunk 1	Chunk2	Chunk3

To save space we don't need a pointer to the first element as it follows after the pointers,if any. We can skip the pointer to chunk1 ;as each pointer is 2 bytes long , we know where chunk 1 starts (6 bytes from the offset).

Example:

Pointer to chunk2	Pointer to chunk 3	Chunk 1 POIs	Chunk 2 Polylines	Chunk 3 Polygons

So now we know the start of each element chunk.

There are 2 problems with this solution:

1) we need to know how many pointers there are in each subdivision
2) we need to know the length of each subdivision

If we didn't know how many pointers there were, we wouldn't know where our first element chunk started – for an answer see later .

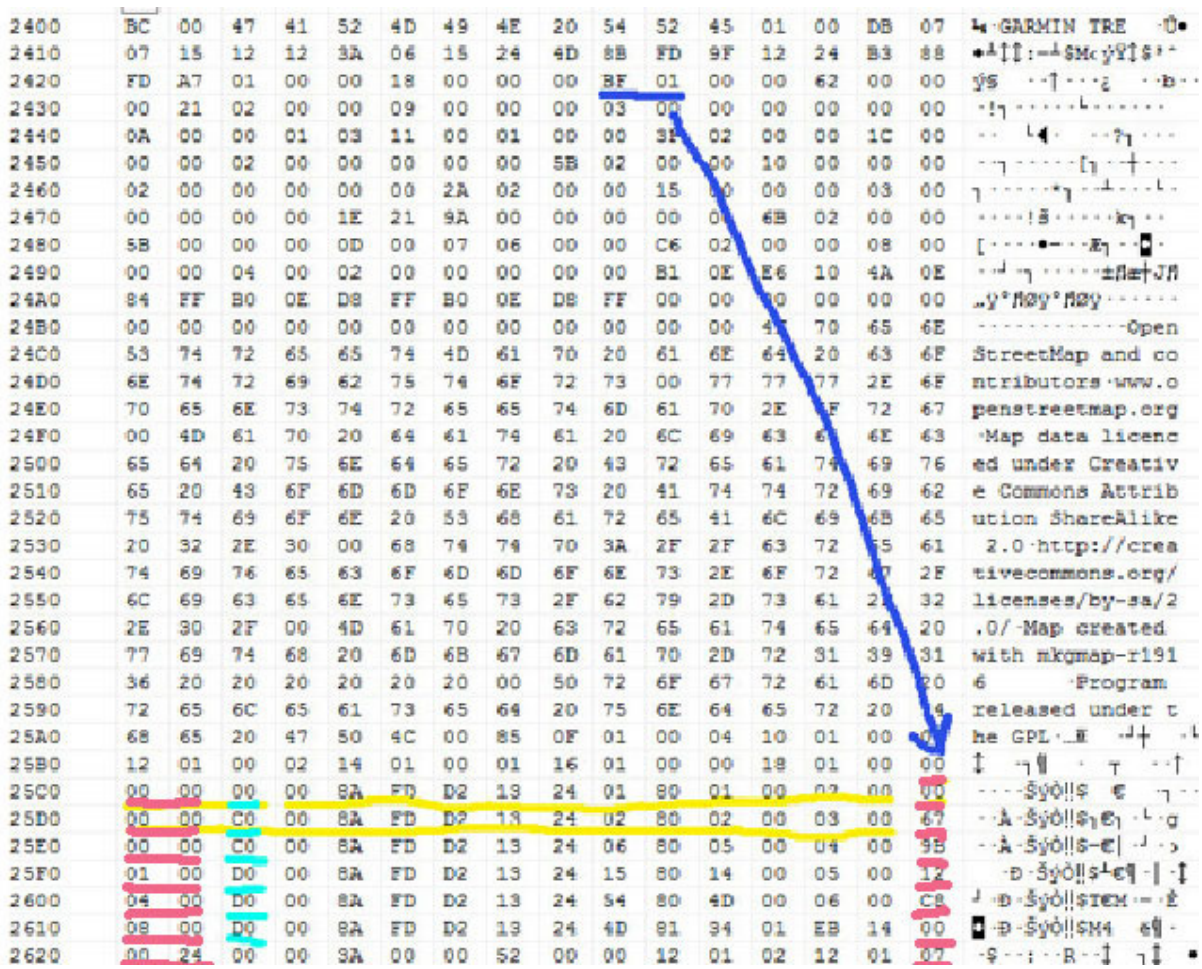
Again , supposing we knew the number of pointers, we could find the first element block, but we wouldn't know where the next *subdivision* started, ie with its pointers

We can't tell , *unless the number of pointers & the start of each subdivision is stored elsewhere in the IMG.* They are not found in the RGN but in another subfile, called the TRE - see below

Finding number of pointers for each subdivision

The information is found in the TRE subfile, specifically at an offset found at TRE + &29, or &2429: ie offset value = &1BF . Add this to &2400.

The dark blue line points to blocks of 16 bytes, each block representing a subdivision containing a number of elements.
The first 3 numbers indicate offsets in the RGN (in pink) , the fourth number of each block of 16 bytes tells you what elements you can find each map level , ie pois and or highways etc, underlined in light blue – ie the first map level = 0 ,second CO , then CO ,DO,DO .



```
2400  BC 00 47 41 52 4D 49 4E 20 54 52 45 01 00 DB 07  GARMIN TRE
2410  07 15 12 12 3A 06 15 24 4D 8B FD 9F 12 24 B3 88
2420  FD A7 01 00 00 18 00 00 00 BF 01 00 00 62 00 00
2430  00 21 02 00 00 09 00 00 00 03 00 00 00 00 00 00
2440  0A 00 00 01 03 11 00 01 00 00 3F 02 00 00 1C 00
2450  00 00 02 00 00 00 00 00 5B 02 00 00 10 00 00 00
2460  02 00 00 00 00 00 2A 02 00 00 15 00 00 00 03 00
2470  00 00 00 00 1E 21 9A 00 00 00 00 00 6B 02 00 00
2480  5B 00 00 00 0D 00 07 06 00 00 C6 02 00 00 08 00
2490  00 00 04 00 02 00 00 00 00 00 B1 0E E6 10 4A 0E
24A0  94 FF B0 0E D8 FF B0 0E D8 FF 00 00 00 00 00 00
24B0  00 00 00 00 00 00 00 00 00 00 00 00 4F 70 65 6E
24C0  53 74 72 65 65 74 4D 61 70 20 61 6E 64 20 63 6F  StreetMap and co
24D0  6E 74 72 69 62 75 74 6F 72 73 00 77 77 77 2E 6F  ntributors www.o
24E0  70 65 6E 73 74 72 65 65 74 6D 61 70 2E 6F 72 67  penstreetmap.org
24F0  00 4D 61 70 20 64 61 74 61 20 6C 69 63 65 6E 63  Map data licenc
2500  65 64 20 75 6E 64 65 72 20 43 72 65 61 74 69 76  ed under Creativ
2510  65 20 43 6F 6D 6D 6F 6E 73 20 41 74 74 72 69 62  e Commons Attrib
2520  75 74 69 6F 6E 20 53 68 61 72 65 41 6C 69 6B 65  ution ShareAlike
2530  20 32 2E 30 00 68 74 74 70 3A 2F 2F 63 72 65 61   2.0 http://crea
2540  74 69 76 65 63 6F 6D 6D 6F 6E 73 2E 6F 72 67 2F  tivecommons.org/
2550  6C 69 63 65 6E 73 65 73 2F 62 79 2D 73 61 2F 32  licenses/by-sa/2
2560  2E 30 2F 00 4D 61 70 20 63 72 65 61 74 65 64 20  .0/ Map created
2570  77 69 74 68 20 6D 6B 67 6D 61 70 2D 72 31 39 31  with mkgmap-r191
2580  36 20 20 20 20 20 20 00 50 72 6F 67 72 61 6D 20  6      Program
2590  72 65 6C 65 61 73 65 64 20 75 6E 64 65 72 20 74  released under t
25A0  68 65 20 47 50 4C 00 85 0F 01 00 04 10 01 00 00  he GPL
25B0  12 01 00 02 14 01 00 01 16 01 00 00 18 01 00 00
25C0  00 00 00 00 8A FD D2 13 24 01 80 01 00 02 00 00
25D0  00 00 C0 00 8A FD D2 13 24 02 80 02 00 03 00 67
25E0  00 00 C0 00 8A FD D2 13 24 06 80 05 00 04 00 9B
25F0  01 00 D0 00 8A FD D2 13 24 15 80 14 00 05 00 12
2600  04 00 D0 00 8A FD D2 13 24 54 80 4D 00 06 00 C8
2610  08 00 D0 00 8A FD D2 13 24 4D 81 94 01 EB 14 00
2620  00 24 00 00 9A 00 00 52 00 00 12 01 02 12 01 07
```

Let's examine the bytes highlighted in blue.

The table below shows you what these numbers mean:

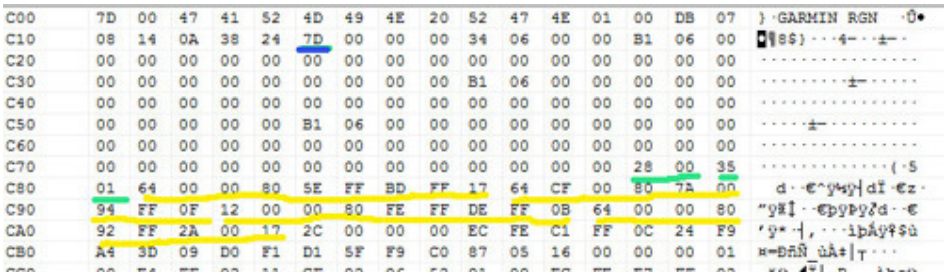
code	pois	Indexes pois	polylines	polygons	Pointers in RGN subdivision
10	√				**0**
20		√			**0**
40			√		**0**
80				√	**0**
C0			√	√	**1**
D0	√		√	√	**2**
E0		√	√	√	**2**
F0	√	√	√	√	**3**

Notice that the last subdivision contains all the elements (&FO) and so we need (4-1) 3 pointers.

Have a look at the picture below; you can see the RGN subfile starts at C00 .

Offset &15 (&C15) (4 bytes) always points to the start of the first subdivision chunk , ie it starts at 7D (C00+7D) .

This number is underlined in blue.



Now look at C7D : underlined in green are 2 pointers , 28 00 and 35 01 – each pointer is always 2 bytes long .

Next, underlined in yellow we find some pois, ie the first one is 64 00 00 80 5E FF BD FF 17 – more later.

Question*: How do I know there are only two (green) pointers? Why is 64 00 not a pointer*?

We know , because in TRE where the pointers are kept, we found this subdivision to contain &D0 types of elements , giving us 3 elements and hence 2 pointers.

Start of Subdivisions in RGN + &29

The first 3 bytes show pointers to a subdivision in the RGN file. Remember to add the offset found at RGN + &15 to each of these values.

25B0	12	01	00	02	14	01	00	01	16	01	00	00	18	01	00	00
25C0	00	00	00	00	8A	FD	D2	13	24	01	80	01	00	02	00	00
25D0	00	00	C0	00	8A	FD	D2	13	24	02	80	02	00	03	00	67
25E0	00	00	C0	00	8A	FD	D2	13	24	06	80	05	00	04	00	9B
25F0	01	00	D0	00	8A	FD	D2	13	24	15	80	14	00	05	00	12
2600	04	00	D0	00	8A	FD	D2	13	24	54	80	4D	00	06	00	C8
2610	08	00	D0	00	8A	FD	D2	13	24	4D	81	34	01	EB	14	00
2620	00	24	00	00	3A	00	00	52	00	00	12	01	02	12	01	07

subdivision	Offset	Type of Data	Number of Pointers in zoom chunk	Zoom level	Real map Levels
0	**00 00 00 or 0**	0	0	A1	5
1	**00 00 00 or 0**	C0	(2-1) =1	B1	4
2	**67 00 00 or &67**	C0	(2-1)=1	C1	3
3	**9b 01 00 or &19b**	D0	(3 – 1)=2	D1	2
4	**12 04 00 or &412**	D0	(3 – 1)=2	E1	1
5	**C8 08 00 or &8C8**	D0	(3 – 1)=2	E2	
6	etc	etc	etc	F1	0
7	etc			F2	

In our example, we should find a new subdivision at offset 67, ie RGN+ &7D + &67
The next new subdivision is at RGN+ &7d + &19B etc

We have named the levels A – F for the sake of clarity .
We can see that zoom level 'E' has 2 pointers, and zoom level F has 5 pointers , remember the above found sequence: 1,1,1,1,2,5

Important: The subdivisions in all mapevels apart from the last one have 16 bytes; all subdivisions in the last level, in our case 'F', have only 14 bytes.

To obtain the address for each subdivision we add the offset to (RGN + pointer found in (RGN+&15)) .

Example: in our case subdivision 5 has an offset of &8C8 . Supposing RGN starts at &E00 and the offset pointer found at E00+&15 points to &7D
This subdivision, therefore, is found at :&8C8 + &E00 + &7D

Note: the size of a subdivision appears to be a critical; perhaps that is why IMGs created using cgpsmapper seem to include a subdivision for almost every highway!

Grouping subdivisions into map levels

We mentioned earlier that maplevels are groups of subdivisions. If only we could find which subgroups belonged to which maplevel . Fortunately we can, but NOT in the RGN subfile.

The information is found in TRE offset 0 x 21 .

It contains information about maplevels, not where they are, but how many there are and also how many subdivisions each map level has and also its resolution(bits_per_coord).

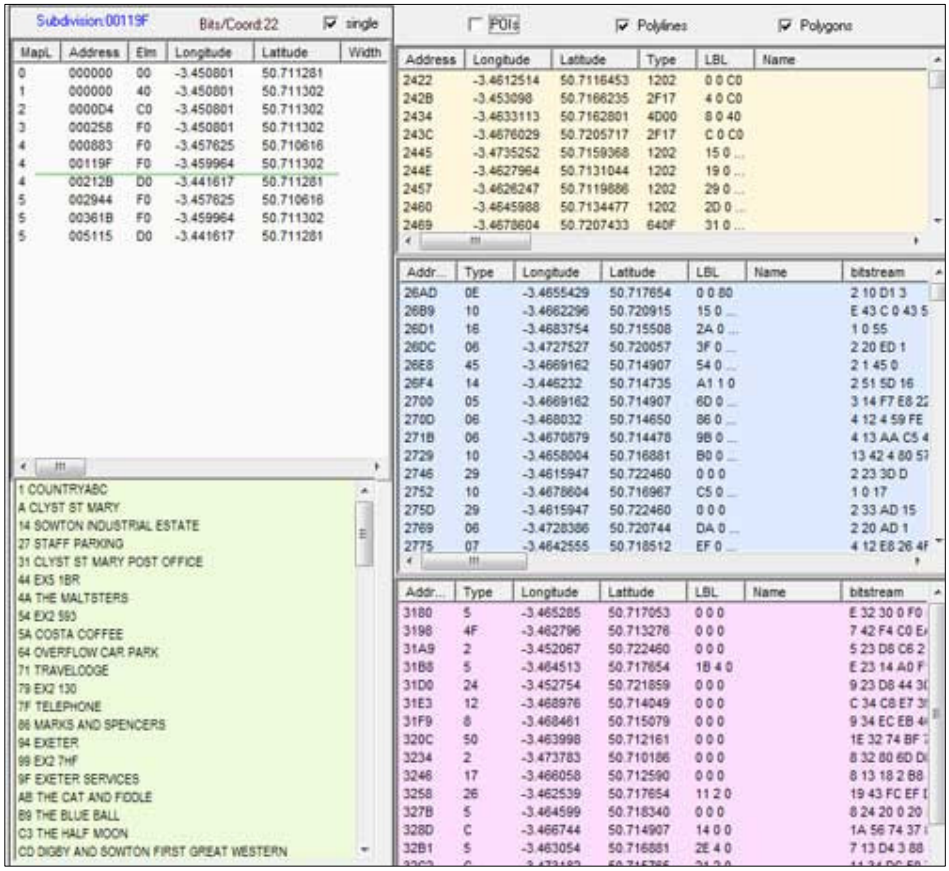
It doesn't actually give you pointers to an address in the RGN but the 3rd column (green) indicates the number of subdivisions in each maplevel.

So we can see that map level 6 starts at subdivision 7

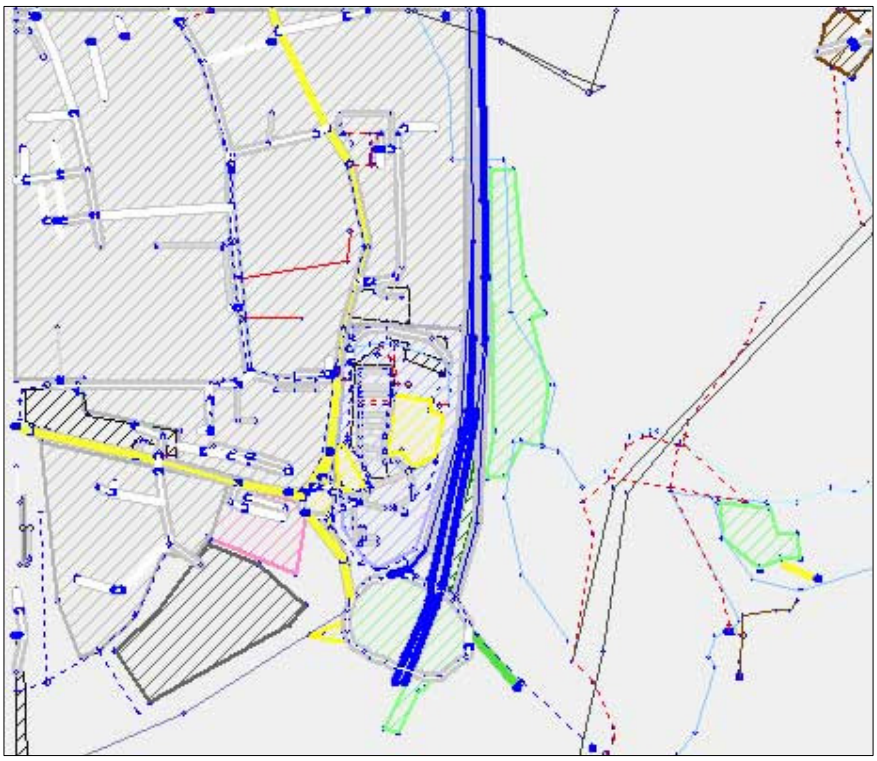
```
5,F,1,0,
4,10,1,0,
3,12,1,0,
2,14,1,0,
1,16,2,0,
0,18,3,0,
```

maplevel	subdivision
1	1
2	2
3	3
4	4
5	5
	6
6	7
	8
	9

Below, an IMG file with 10 subdivisions and maplevels 0 to 5. Maplevels 4 & 5 both have 3 subdivisions. Maplevel 0 contains no elements, Maplevel 1 only polylines (40) etc.



Highlighted are the contents of subdivision 119F at maplevel 4 .
Notice F0 meaning pois,polylines and polygons. The creamy list contains all the pois and indexed pois, blue polylines and purple polygons,plotted below including nodes.



'the RGN block and beyond'

So, now we know how many map levels there are, but we still don't know how long the last map level block in the RGN is.

Fortunately, Garmin gives us the size of the RGN block, ie from the first subdivision containing pointers and po1/highway/polygon data, to the end of the last one.

This is found at RGN + &2D

Now, interestingly there is some special data BEYOND this block not documented by Mechalas.

So, in addition to the subdivisions mentioned above, the RGN contains other chunks of data found at pointers beyond &15.

Offset in RGN		bytes
1d	pointer	4
21	Length of block	4
39	Pointer to block	4
3d	Length of block	4
55	Pointer to block	4

Some imgs store highways with types &100+ in the 'green' block . These types are used to perform overlays ; this in theory ensures that certain highways,ie bridges, when given types &100+, acquire the highest draw order and can overlap say Motorways. This, for some reason does not always happen. More later. – see Polylines

Orange block is reserved for polygons with types &100+ - see Polygons.

Locked TOPO maps

You may find that these locked maps do not display the word ‘Garmin’ in a hex editor. If so, data needs to be unscrambled. Find the first hex number and use the XOR function , ‘xorring’ every byte by the first byte found. This will , ofcourse, still keep the file locked, but at least it’s readable.

Locked TOPO maps have the subdivisions pointers in the TRE encrypted.
(For those in the know, bytes &24 - &27 are used to unscramble the zoom level chunk and replaced with new values)

This means you need to guess where each zoom level chunk starts and ends in the RGN. This RGN data is itself not encrypted, so you can still read the first RGN map level chunk, including its pointers, however you have no idea where it ends.

The problem is that pointers could be read as POIs etc and pois can be mistaken for polylines. However, you could in theory when parsing , build in, best fit scenarios to check if the next piece of data is a pointer, a POI or a polyline given the fact that coordinates couldn’t suddenly escape the given boundaries.

If an IMG file contains pois,polylines or polygons with extended types, ie 0x100+ (see below) , then these can be read and plotted without any problems. Even pointers to different subdivisions remain unscrambled – see TRE7.

LBL

Where are all the names of streets,pois etc kept?

They are stored in the LBL subfile. However when you examine it, you more than likely won't recognize any labels ,as they are all encrypted.

Lets examine a POI data stream found in a RGN zoom level

46 DF 00 00 49 FF BB FF 02

The first and last 'green' byte denote type and subtype , so this POI's type is 4602

The next three yellow bytes DF 00 00 are and offset in LBL , ore more precisely in LBL1 which is an offset from the start of the LBL subfile.

However, bits 7 & 8 in the 'third byte' are reserved for something else:

Sometimes the third byte is 80, which implies that it is also found in the NET subfile if it's a highway. More importantly, if the third byte is a 80,40 C0 ,82,C2 etc then the pointer **DOES NOT** point to an offset from the beginning of the lbl1 labels/names block. Instead, it points to a **different** block where other information is found, including a pointer to the label lbl1 block – more later

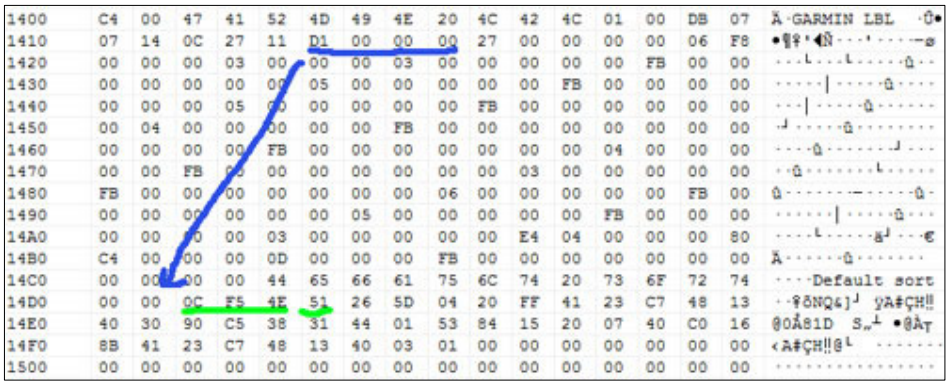
For our purpose, we could just look at the first two bytes (you also need to check if bits 1 to 6 are set in the third byte - only used if labels are found a long way from the beginning of this block).

It tells me that the name of the poi is found at offset 00DF (ie &DF) . The other 4 bytes following the 'yellow block' provide the x and y coordinates.

However, it is not an offset starting from the beginning of the LBL subfile.

Instead, it is an offset from where the label block within the LBL starts ; the start of this label block is defined in LBL + &15 or LBL1.
Each name in the label block ends with 00 if it's not encoded.

Let's have a look at an example:



1400	C4	00	47	41	52	4D	49	4E	20	4C	42	4C	01	00	DB	07	Ä·GARMIN LBL ·Û•
1410	07	14	0C	27	11	D1	00	00	00	27	00	00	00	00	06	F8	•¶§'◄Ñ···'····÷°
1420	00	00	00	03	00	00	00	03	00	00	00	00	00	FB	00	00	···└···└·····û··
1430	00	00	00	00	00	05	00	00	00	00	00	FB	00	00	00	00	·····│·····û····
1440	00	00	00	05	00	00	00	00	00	FB	00	00	00	00	00	00	···│·····û·····
1450	00	04	00	00	00	00	00	00	FB	00	00	00	00	00	00	00	·┘·····û·····
1460	00	00	00	00	FB	00	00	00	00	00	00	00	04	00	00	00	····û·····┘···
1470	00	00	FB	00	00	00	00	00	00	00	03	00	00	00	00	00	··û·····└·····
1480	FB	00	00	00	00	00	00	00	06	00	00	00	00	00	FB	00	û·····═·····û·
1490	00	00	00	00	00	00	05	00	00	00	00	00	FB	00	00	00	·····│·····û···
14A0	00	00	00	00	03	00	00	00	00	00	E4	04	00	00	00	80	····└·····ä┘···€
14B0	C4	00	00	00	0D	00	00	00	FB	00	00	00	00	00	00	00	Ä·····û·····
14C0	00	00	00	00	44	65	66	61	75	6C	74	20	73	6F	72	74	····Default sort
14D0	00	00	0C	F5	4E	51	26	5D	04	20	FF	41	23	C7	48	13	··♀õNQ&]┘ ÿA#ÇH‼
14E0	40	30	90	C5	38	31	44	01	53	84	15	20	07	40	C0	16	@0É81D S„└ •@À▬
14F0	8B	41	23	C7	48	13	40	03	01	00	00	00	00	00	00	00	‹A#ÇH‼@└ ·····
1500	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	·····

We know all label data starts at offset &15 from the beginning of the LBL subfile.
Strangely, it points to 00 (LBL + &D1). Add 1 and you get the sequence OC F5 4E 51

When you cross-check in the right column, below Default sort, it just shows gobbledy gook.
Let me tell you that all the values underlined in green read :'COUNTRY'
It looks as if the word is zipped in some way and most likely 6 bit encoding has been used.

First you need to change each of the 4 bytes into a binary format of zeros and ones . We don't know if it's just 4 bytes, it could be more – see later.

In basic this would be:

```
For n = 7 to 0 step -1
If (byte and 2^n) = 2 ^n then string=string+"1" else
string=string+"0"
Next
```

Do this for each byte until you get a string which begins like this :

000011001111010101001110…….

Now split them into chunks of 6, as this is how most of the IMGs are encoded.

000011 001111 010101 001110 …….

Chunk 1 : 0 0 0 0 1 1

Read from *right* to left and you get:

1 1 0 0 0 or 2^0 + 2 ^ 1 + 0+ 0+ 0 = 3 which is the third letter ie 'C'

Chunk 2 : 0 0 1 1 1 1

Read from *right* to left and you get:

1 1 1 0 0 0 or 2^0 + 2^1 +2^ 2 +2^3+ 0+ 0 = 15 which is the 15th letter, ie 'O'

(The reason why we had to add 1 was because in our example the offset (+ 1) was given in the Country records offset at lb + 1F- see further)

How do we know we've come to the end of a word? Garmin have though of this: if the 6 bit number is > &2f then you've reached the end of your label. The next label starts in the next byte, so any superfluous bits are just discarded and not used as the beginning of the next word.

Lbl pointers NOT directly pointing to lbl1 label block

Pointers are always 3 bytes, but sometimes the third byte ends in 80,82,C0,C6 etc

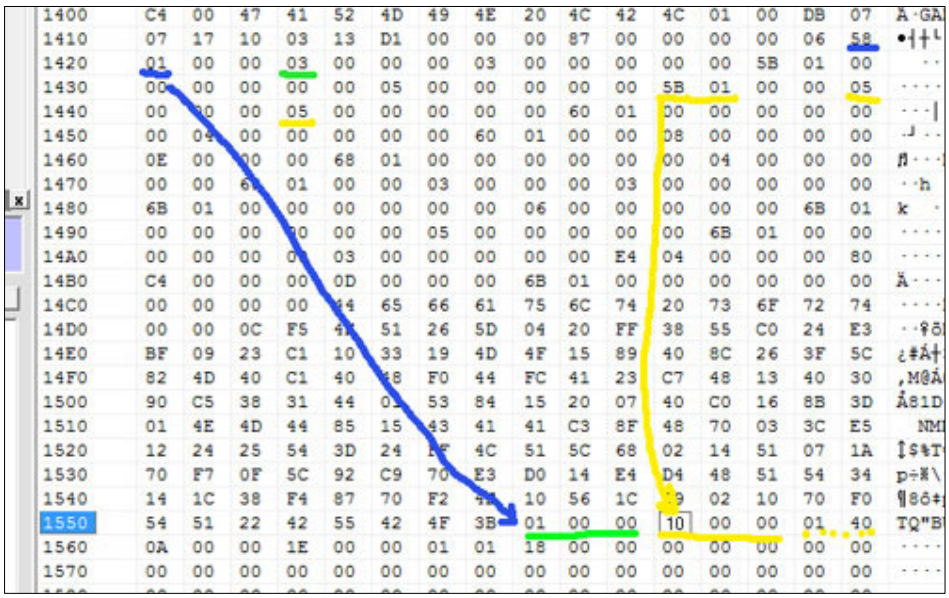
If bit 7 of the third byte is set then your lbl label refers to an offset in NET1 where you can find a 3 byte pointer to LBL1. Remember : Pointer = 1st byte + 2nd byte + (3rd byte) mod 32
Net1 starts at offset 0x15 from the beginning of the NET subfile.

Example: 60 00 C1

60 00 01 (&C1 mod 32) points to offset &010060 from the NET1 block. Here we will find a pointer to the main label block. Bit 7 of this byte may also be set! So, pointer NET1 Byte1+ NET1 byte + (NET1 byte 3) mod 32 should point to somewhere in LBL1, even if it is a blank label.

There are several offsets/pointers found in the LBL header :

LBL Offset		size
1F	Country	
2D	Region	
3B	City	
49		
57	POI	
64		
72	ZIP Post Codes	
80	Highway	
8E	Exit	
9C	Highway data	



Look at LBL + 1F , underlined in blue: it reads 58 01 - so offset is &158 from LBL, ie &1558

There you will find underlined in green a 3 byte pointer : 01 00 00 , ie 1 and this is our 'elusive' offset.

There are only 3 bytes to look at (see green 03 at &1422) . If there were 2 more regions then the length (03) will be multiples of 3, ie 06.

Next, there appears to be some more pointers at 155B, underlined in yellow.

This is a yellow 5 byte chunk, 10 00 00 01 40

The first 3 bytes point to the label data segment (ie 10), the next 2 bytes are to do with 'city information'

Symbols

If you parse the LBL1 from the label offset you should get all the labels. When labels are encoded in 6 bits, the start of the next label is always the next byte.

You may get funny letters but check Mechalas' section on symbol letters– it's fairly straight forward except that 0x1B should be 0x1C.

More than 1 label in NET

A highway can have up to *four* label pointers in NET, ie

6C 00 00 72 00 00 91 00 00 12 01 80

The last label is terminated with bit 7 being set , ie 80 in our case. Thia shows 4 labels, one starting at 62 00 00 and the last at 12 01 80.

This principle of the 7th bit when set terminating a list is used in other subfiles as well , ie NOD.

For more information regarding other highway properties see NET.

POIs

Points of interest all have a type number and a subtype number, ie type = 30 and subtype=01 . The subtypes are supposed to be subsets of the main type: ie main type = amenity restaurant and subtype = French cuisine

The length of each block varies depending on whether the subtype = 0 or not.

POIs with subtypes

type	Lbl I	Lbl II	Lbl III	longitude		latitude		subtype

POIs with no Subtypes

type	lbl	lbl	lbl	longitude		latitude	

How do we know if the poi has a subtype or not?

Answer: if (lblIII and 128)=128 then it contains a subtype.

This is where Mechalas is incorrect: it is not the bit 8 of first byte, but bit 8 of the 4th byte.

POI labels

If bit 7 in the above LBLIII block is set then the labels for all pois are kept in a block named LBL6 ie found at LBL + 4 byte pointer at (LBL + &57)

This marks the beginning of series of 3+ byte chunks, the first 3 bytes of each chunk shows pointers to LBL1 label blocks.The other bytes indicate presence of phone-numbers etc.

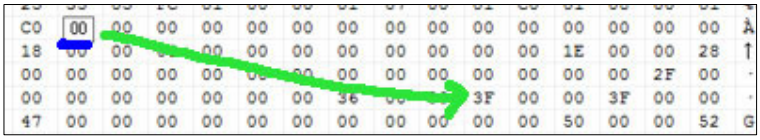
Generally,we find 3 byte chunks showing pointers to LBL 1

Example :

POI: 46 39 00 C0 B5 FD 53 FE 11

Bit 8 of the lblIII pointer is set, ie &C0 : this means it has a subtype : Bit 7 is also set ; this means 00 39 is pointing to LBL 6 . (&C0 = &40 + &80)

Now start from the beginning of LBL 6 ,underlined in blue and add &39 . It points to 3F 00 00



This,finally, is our lb1 pointer and hey presto we get the name of an amenity at offset 3F from LBL1!

POIs with extended types

These are special POIs which may not show up on your GPS or Mapsource/Basecamp.

They could have types of 0x101, 0 x 10101 etc and are found at RGN4 + Offset &55 with length of block at RGN4 +&68 containing additional information. The length of each block is variable depending on bits 5 - 7 of the 2nd byte .

In its simplest form its structure is:

Type + &100	Sub type mod 32	longitude	longitude	latitude	latitude	lbl	lbl	lbl

Example : 14 35 45 00 23 01 06 2E 00

This is a poi with type: &100 + &14 + &35 mod 32 = &11415

It has a label (yellow) at offset &2e06 from LBL1:.
We know it has a label as bit 5 was set , ie &20 + &15

Another example encountered has bit seven set:

Example

02 A1 90 FF 9F FF CD 00 00 E0 09 00 00 00 00 01

The bit stream following the yellow lbl label is at present unclear. It is possible that E0 marks beginning of a possible bitmap stream/index with 09 being a flag and next 3/4 bytes a pointer to its location. (The MDR has similar 2 byte codes , telling us how many bytes we should expect next, ie number of characters and number of bytes to denote the index.)

For more information see TRE7

POLYLINES

Polylines ,like polygons, have a more complicated variable length.

The first 9 bytes are fixed :

0	1	2	3	4	5	6	7	8
type	lblI	lblII	lblIII	longitude	longitude	latitude	latitude	length

Because the highway node information can exceed 256 bytes we need to know when the length is > 256 and when it is not.

Answer: if the (type byte and 128 = 128) then we know the length is determined by 2 bytes.

The first 8 bytes gives us the starting point coordinates of the highway – however, it's as an offset from the centre of a box defined by each subdivision in TRE .

Polyline Labels

If an IMG is not routable then the 3 LBL byte chunks behave normally and show pointers to lbl 1

If bit 8 in the above LBLIII block is set then these highways are routable. In which case the labels of these highways are kept in a different block named NET1 ie found at NET + 4 byte pointer at (NET + &15)

Railway lines , (type 0 x 14) are not routable (in theory) so lblIII should not have bit 8 set.

Polylines withextended types 0 x 100+

These are located in RGN3 offset &39 and are not routable; length of this block is found in RGN offset &3d.

Their structure is quite different from polylines with types < 0 x &100.

0	1	2	3	4	5	6	7+	3 bytes
Type + &100	Sub type mod 32	longitude	longitude	latitude	latitude	pointer	length +data	lbl

Example : first 2 bytes are : 12 24

Add &100 to 12 and 24 mod 32 = 4 : this makes it type 11204
If the second byte ,ie 24, has bit 5 set (ie &20) then the polyline has text ; in which case ,the 3 byte LBL pointer is stuck at the end of its data stream.

No text :

003F8590: 0F 04 23 FF 10 00 11 30 A6 10 12 85 F0 02 01

With text:

003F8590: 0F 24 23 FF 10 00 11 30 A6 10 12 85 F0 02 01
003F85A0: 38 70 02

Length of a polyline type 100+ block

Byte 7+ defines the length of data to draw the polyline.

In the example before length is highlighted in green : ie &11 or decimal 17

If byte 7 is even then an extra byte will be used to calculate its length.

In our case it's odd so only one byte is needed.

Single Byte Algorithm: (byte 7 -1) / 2

Two Bytes Algorithm: (byte7 + byte 8 * 256) / 4

Note: the length refers to the data steam to define the complete polyline, so it remains the same with or without LBL pointers. For more information see TRE7.

POLYGONS

Data structure is the same as for polylines.

Polygon Labels

Again see polylines

Polygons with extended types 0 x 100+

These are located in RGN2 offset &1D ; length of this block is found in RGN offset &21.

Length of a polygon type 100+ block

See Polylines.

Plotting Coordinates

Finally we come to plotting our elements.

The coordinates are stored in 2 byte offsets from the centre of your current zoom level map

Earlier on we gave the following example
for map zoom levels found in TRE where
the last two digits determine the number of subdivisions
in each map level.

```
85,F,1,0,
4,10,1,0,
3,12,1,0,
2,14,1,0,
1,16,2,0,
0,18,5,0,
```

This tells us that we have 5 different map levels. Remember, at each level elements may be plotted. The first level you encounter tends to be empty, not referring g to any elements and is used for determining boundaries.

Look at the last level : 0 , 18 , 5 ,0

The second number (&18) is vital to the way elements are plotted. It is referred to as the bits per coordinate (bpc)

The formula for getting latitude and longitude degrees : 1 garmin unit = 360/(2^24)

24 (or &h18) represents the bpc

At each zoom level you swap 24 for the second number in our table . Remember, this will be different for each IMG.

In our case the various bpcs are : &F, &10,&12,&14,&16,&18 , increasing the accuracy of the coordinates.

Plotting POIs

64 15 03 C0 1F 00 1C 00 0F

You need to add these two byte chucks in green to the 3 byte latitude + longitude centres defined in TRE +&29 – see earlier. Add the first two to the latitude,and the second 2 to the longitude.

Next, multiply each by 360/(2^24) to obtain degrees

Check if the value of your two byte chunks is >&7FFF:

If it is, then the result is negative , ie -(65536 - value),

Plotting Polylines

Before attempting to plot polylines or polyhedrons, you must be familiar to some extent with Mechalas description of bitstream parsing. This is heavy going but a few additional examples may help:

06 E0 01 00 5A FF 76 FF 11 23 A5 C2 52 93 4A 77 EA 5C F0 F0 8C 21 2A 5A 4B 14 01

This represents a residential highway (06) with LBL1 ref at 00 01 E0 and longitude and latitude starting at offset 5A FF ,76 FF respectively from the centre of your zoom level map.

We know the start of the highway , but not the end, or any other nodes along its line. They are all compacted in a bit stream, highlighted in blue.

The length of this bitstream always follows the latitude byte and is highlighted in green :&11 ie 17 bytes. The next byte,23, in yellow tells us 'something' about how many bits are grouped together to determine our longitude and latitude. This may not be the same number – see further.

So far, so good. Now the fun starts:

We need to 'translate' the bit stream into binary, reading from left to right , starting at A5 and finishing at 01. Lats and longs are now determined by bits, NOT bytes, to save space . So we now have to find out how many bits are needed for each!

Part of this information is also held in the yellow byte, part in the *first 'blue' byte* of the bit stream.

the first bitstream byte

Before we examine the meaning of our A5 here are 2 examples of first bytes of a bitstream, starting LSB , from bit 0 .

a) 1011 00101 …….. etc
b) 1110 01101 ……. Etc

The first bit is most significant;

if it is set then

1) all the longitudes in this line have the same sign ;
2) the second bit tells you whether they are all positive (0) or negative (1).
3) The third bit tells you about latitudes; if set then the fourth bit gives you the sign

you can see that both a and b start with the first and third byte being set (=1)

Longitude	Longitude	Latitude	Latitude	Effect
1= Has same sign	1= - 0 = +	1= Has same sign	1= - 0 = +	
1	0	1	1	Going east and south
1	1	1	0	Going west and north

Now examine the first byte in our example above , ie A5:

In binary this is 10100101 bit 7 to bit 0

Next, reverse the bits and we see that it starts with 1010 0101 bit 0 to bit 7

This implies that longitude is always positive and latitude is positive as well (1111 0101 would have signified all values being negative)

How is this going to help us to determine the bit lengths of our latitude and longitude?

If it is always positive or negative the shape of the line tends to be a curve. If you want to check your code look for power cables or motor ways, they should general start with a 4 bit sign determinator.

The 'official' algorithm:

Mechalas gives the following formula:

Longitude = 2 + base value + longitude sign + extra bits set in LBL (*but see further!!!)*
Latitude = 2 + base value + latitude sign + extra bits set in LBL

I have found this to be incorrect*; in my opinion* it is:

Longitude = 2 + base value + longitude sign
Latitude = 2 + base value + latitude sign

If the extra LBL bits are set then add 1 bit - this bit seems indicated the beginning of a line if set (ie 1).

When the Extra bit is set additional information about the highway is held in the NET and NOD subfile regarding speed and road type. It also means that the highway is routable.

If the sign of latitude is always the same then the latitude sign value = 0 else it is 1. Same applies to longitude.

In our example all longitude and latitude values remain the same ,ie always positive or always negative.

Let's return to the base byte (yellow above , ie …FF 11 23 A5…) : ie 23 :

1st 'digit' refers to latitude, second to longitude (MSB to LSB)

Longitude = 2 + 3 (base value) + 0 = 5

Latitude = 2 + 2 (base value) + 0 = 4

If the base value is higher than 9 , ie B4 , 6A, or AC etc) then see Mechalas.

Starting to parse bitstreams

Next, we start parsing the bit stream and begin with the fifth bit, because we've already used the first 4 to determine the sign for our coordinates.

Remember, our starting point is not always the 5th bit ;it could be 3rd or 4th ; see following examples.

In our previous examples the purple bits always were 4 bits . Now, some examples when this is not the case.

Example 2

100 1001 …

The first two bits are as above,ie 10, but then latitude is set to 0 (3rd bit) meaning its sign is variable and could be positive or negative. There is now no need for a 4th bit. We know that our longitude is always positive, and our latitude is variable, both positive and negative – total number of bits = 3.

Longitude = 2 + (base value) + 0 + 0
Latitude = 2 + (base value) + 1 + 0 (1 indicates value being variable)

We start parsing after the 3rd bit, ie 1001…

Example 3

010 1011 …

In this case the longitude bit starts with zero, meaning its sign is variable

Longitude = 2 + (base value) + 1
Latitude = 2 + (base value) +0

Again we start parsing after the 3rd bit , ie 1011

Example 4

00 10010

Here both longitude and latitude are 0 meaning both signs are variable ; no more bits needed to mark our signs.

Longitude = 2+ (base value) + 1
Latitude = 2 + (base value) +1

Parsing starts after the 2nd bit.

If you are writing your own code it is recommended you look at the last subdivision containing polylines as defined in TRE, as we don't need to bother about left shifting the values – more later.

(There is a minor binary value error in Mechalas description,ie 0 x ab)

We now know the length for each longitude and latitude chunk and can start parsing; remember the values are added to the coordinates of the centre of your maplevel block – see plotting POIs

Returning to our example

06 E0 01 00 5A FF 76 FF 11 23 A5 C2 52 93 4A 77 EA 5C F0 F0 8C 21 2A 5A 4B 14 01

1) start with 5th bit of your total stream

2) longitude = 3 bits and latitude = 3 bits: so group the rest of your bitstream into sets of 3's

x of point 1 : 5A FF in degrees: (FF5A + centre longitude) * 360/(2^24)

y of point 1 : 76 FF in degrees: (FF76+ centre latitude) * 360/(2^24)

x of point 2 : x=x + decimal(first 3 bits) in degrees : x * 360/(2^24)

y of point 2 :y=y + decimal(second 3 bits): in degrees : y * 360/(2^24)

x of point 2 : x=x + decimal(third 3 bits) : x * 360/(2^24)

y of point 2 :y=y + decimal(fourth 3 bits) : y * 360/(2^24)

Plotting Routable polylines

If bit 6 of the 3rd byte of the lbl pointer is set then the extra bit =1
In its simplest form 1 extra bit is added to the Latitude only and an extra bit is added to the start of the bitstream. Interestingly, not all highways of the same type in a subdivision are marked as routable, perhaps they are at the end of the map boundary, or not connected.

example: bitstreams starting with 1010 ; longitude in yellow, latitude in green

100 110 1111 101 1001 without routing (latitude sign is variable)

100 0 110 1111 1 101 1001 with routing (latitude sign is variable)

Notice only 1 extra bit per coordinates. *We have not come across examples of extra bits being added to longitude as indicated by Mechalas.*

Importantly and not mentioned by Mechalas*, the extra bit is added to the beginning of each longitude.*

It is not clear why the extrabit is sometimes 1 and sometimes 0 , as it is not a simple case of marking a junction or not.

For more information see TRE7

Left_shifting Coordinates

The more you zoom out , the more sparse the map is going to be. You don't need to plot all POIs and your highways require fewer nodes, so the length of each bitstream tends to be short.

Also, crucially, you can reduce the accuracy of your coordinates and save bits.

Bits_per_coord

Map Level	Bits per coord	subdivision	subdivision
85	&F	1	0
4	&10	1	0
3	&12	1	0
2	&14	1	0
1	&16	2	0
0	&18	5	0

When we convert our data to degrees we use the formula:

Long= x * 360/2^24 Lat: y * 360/2^24

The third column, bottom row contains this number, &18 ie 24 dec

Each time we zoom out we use a different factor: 16,14,12,10,F

So, in our example, when we zoom out, we need to multiply our coordinates by: * 360/2^22

Left Shifting

However, each time we zoom out, before we obtain our degrees, we need to left shift our coordinates using the following formula: 24 – bits_per_coord.
Left shift means 'increase', in the sense that positive becomes more positive and negative more negative.

POI Example :

64 15 03 C0 1F 00 1C 00 0F

Supposing this POI was found in a maplevel 2 : we read off and find our bits_per_coord : &14 (dec 20)

First change 1F00 into bits. 1111000 , starting from bit 0 to 7

We left_shift by (24-20) ie 4 to get 00001111000: 576 or &h240

Take care when numbers to be left_shifted are negative, ie &FFF7.

Note: you need to left_shift all two byte values *before* adding them to the current coordinates if resolution is < 24 . Three byte values are NOT left_shifted.

Plotting Polygons

Polygons are parsed in the same way as polylines.

You will notice that most polygons are not drawn at the highest zoom level/ sublevel and that lower zoom levels generally contain a bounding box of &4B or 4A.

Interestingly and perhaps not surprisingly ,shapes are not closed.

Special cases in a bitstream

Mechalas has given us some valid pointers to how we need to parse a bitstream chunk with ONLY its last bit set, ie 001 or 00001 etc (LSB to MSB).

However,unfortunately his description is somewhat incomplete.

Only cgpsmapper and topo maps seem to use this feature , so it is worth experimenting with cgpsmapper to unravel its obvious complexity.

Use gpsmapedit to create various zigzag lines and save as a mp. Then export using cgpsmapper.

Regard 0001 etc as a flag to indicate special cases to create larger numbers,either negative or positive.

The sign value is determined by what follows!

Examples: (from LSB to MSB)

a) 00001 001001 special case followed by negative number .

This has the effect of increasing its *negative* value - documented by Mechalas.

b) 00001 001010 special case followed by positive number

This has the effect of increasing its *positive* value – not documented.

Value = 2^4+ 20

c) There is an additional case,also undocumented , when ,say, 0001 is followed , often several times, by another 0001 , until a lower bit is set. - this only works if the extrabit is not set (information given by Attila)

For example:

0001 0001 0001 1100

This creates a value of 2^3 (0001) + 2^3 + 2^3 + 3 (1100)

A visual example:

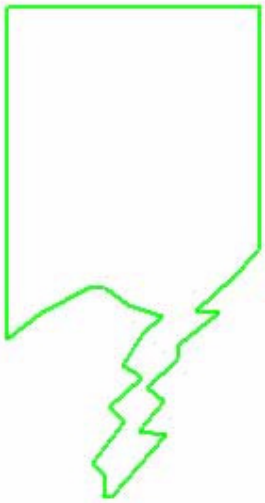
The following bitstream of a polygon contains somewhere in the middle some consecutive segments with last bit set only.

0000001 0000001 0000001 0000001

```
3F 44 94 D9 54 B3 C1 CF 10 20 FC 52 B4 9F EE 55 53 EC 62 34 C8 0F
FC 43 ED 02 81 43 AE 30 81 DC 0C 92 45 4F 80 1B 30 18 8B 43 8B 20
3B DC 00 24 5B CB 06 00 81 40 60 00 08 04 02 4B 00 00 10 58 04
```

```
(length=&3F ,base value=&44 etc)
```

And looks like this with polygon closed:



TRE from 0x4a

Offset	description	bytes
0 x 4a	Polylines Resolution Block	4
0 x 4e	Length of block	4
0 x 52	Length of record block (ie L= 2)	4
0 x 54	Number of L+1 bytes ? other length	2
0 x 56	other length ?	2
0x 58	Polygon Resolution Block	4
0 x 5c	Length of block	4
0 x 60	Length of record block (ie L= 2)	4
0 x 62	Number of L+1 bytes ? / other length	2
0 x 64	other length	2
0 x 66	POI Resolution Block	4
0 x 6a	Length of block	4
0 x 6e	Length of record block (ie L= 3)	4
0 x 70	other length ? (ie L=5)	2
0 x 72	other length ?	2
0 x 74	MAP ID also used in mp section of gmapsupp	4
0 x 78		4
0 x 7c	Pointers for subdivision for extended elements TRE7	4
0 x 80	Length of this block	4
0 x 84	Size of record ie 0 x 0d	2
0 x 86		2
0 x 88		2
0 x 8a	Extended types and draw order pointer TRE8	4
0 x 8e	Length of this block	4
0 x 92	Size of record	2
0 x 96+	Values used to encrypt data based on map-id	2
0 x 98		2
0 x 9a - AD	encrypted key last 4 bytes get set to zero after decryption ! TRE1 gets decrypted - firts line of mapsets	19
0 x ae	TRE 9	4
0 x b2	Length of block	4
0 x b6	Size of record (0 x 5)	2
0 x b8		2
0 x bc	TRE 10n block	4
0 x c0	Length of TRE10	4
0 x c4	0 x 01	2?
0 x c6		4?
0 x ca	NT TRE11? &1A	4
0 x cE	Must be 2 as CF as a new header	2
0 x CF	4 byte parameter	4
0 x d3	Parameters 03 00	2
0 x d5	A block	4

0 x e3	block	4
0 x e7	size	4
0 x eb	Record length (6)	2
0 x ed	Block looks like a pointer or length	4
0x f1	block	4
0 x f5	length	4
0 x fb	block	4
0 x ff	length	4
0 x 103	Record length (?) 9	2

See headers up to &110

Some non NT imgs have a TRE header with length 0 x ca but most of are 0 x bc long.

The latest 2012 TOPO imgs have headers up to &da

No idea what TRE10 or 11 represent.

A lot of the TRE is now clear and documented ; but there is still a lot to do!

To give you a taster ,the PIDs are kept in a single byte with say EF down to E6 incrementing the PID and E0 to E5 decreasing its value! Offset rule varies and is linked to values stored from 0x96 . Similarly with the FID (2 bytes) , proceeding the PID (1 byte). There is no problem obtaining both values in a gmapsupp as they are kept in the mps section.

TRE7

Each block of extended elements, contains elements at various resolutions. So, if your IMG contains extended pois or polylines etc then they too are plotted at different resolutions.

Trouble is, that without any pointers, it is impossible to plot these extended elements correctly as they may need to be left_shifted

Fortunately,TRE7 provides essential pointers for each subdivision. Interestingly, in locked files these are not scrambled!

Pointers for each subdivision are found at 0x7C offset from TRE, called TRE7, usually in blocks of 13. Length of this block at 0x80

The size of each block is defined in TRE + &84 , ie &0D

So, the length of each group of extended pois is determined by the beginning of the next offset or then end of the block itself. Each offset is always calculated from the beginning of each block of extended elements.

Polygons 4 bytes	Polylines 4 bytes	POIs 4 bytes	Refers to number of element types in nxt subdivision (0 - 3) 0 means nothing to follow 3 means pois polylines & polygons)

example of tre7 (magenta number of elements in next subdivision)

```
00000000000000000000000000 0
00000000000000000000000000 1
000000001A0000000000000000 2
590000006F0000000000000000 2
72030000D10000000000000000 2
E7060000BA0100000000000000 2
350B000086030000000000000 2
720D000033040000000000000 3
90100000E10500005700000000 3
F3180000F1090000A500000000 0
```

However, it can be more complex particularly if size of records are >13. In fact it is not clear what additional information has been added. Again, then element indicator, doesn't seem to follow the above mentioned rules. As extended types are designed for marine maps, the additional information may include min max depths for each subdivision, as in the DEM subfile.

example 2

```
0000000000000000F0000000060320000244000 00C2870100F4250200
0000000000000000F0000000060320000244000 00C2870100F4250200
0000000000000000F0000000060320000244000 00C2870100F4250200
0000000000000000070000000060320000244000 00C2870100F4250200
0000000005020000070000000060320000244000 00C2870100F4250200
000000007C0400000600000000060320000244000 00C2870100F4250200
00000000DD0400000400000000060320000244000 00C2870100F4250200
00000000E5050000070000000060320000244000 00C2870100F4250200
00000000D8080000040000000060320000244000 00C2870100F4250200
000000004F0900000500000000060320000244000 00C2870100F4250200
00000000C4090000050000000060320000244000 00C2870100F4250200
00000000060A0000040000000060320000244000 00C2870100F4250200
000000003B0A0000040000000060320000244000 00C2870100F4250200
00000000580A0000040000000060320000244000 00C2870100F4250200
00000000580A0000050000000060320000244000 00C2870100F4250200
00000000770A00000F0000000060320000244000 00C2870100F4250200
00000000EB0C00000D0000000060320000244000 00C2870100F4250200
00000000660D0000000000000060320000244000 00C2870100F4250200
00000000660D0000040000000060320000244000 00C2870100F4250200
9A030000BA0D0000669020000A2320000CE4E0000358A0100F6250200
24070000270E000007B6040000DE320000ED5400003D930100F6250200
780A00004E10000004F6060000383400002A6900007B980100FA250200
```

TRE8

This block located at TRE + &h8a contains all the extended types and their draworder found in a particular IMG file. Each element data can be 3 bytes or 4 bytes long.

Example: &10F08

Typ mod &100	draworder	subtype	?
F	2	8	0

An element with the lowest drawnumber seems to be at the highest level, ie the top,

The order in which they are plotted is:

Polylines ,followed by polygons,followed by POIs. Interesting that POIs can have a draworder!

an example of TRE8

```
1 1 2 0
1 1 3 0
1 1 4 0
6 1 1 0
6 5 3 0
6 5 4 0
```

TRE9

Nothings is known about this section; if present , there only seems to be one record of 5 bytes

NET subfile

Here we find additional data concerning routable highways ,such as its length , its direction (if one way),the maximum speed allowed, and its house address information if any.

The header looks like this:

NET Offset	NET Header
00	Header Length
02	GARMIN NET
15	Pointer to beginning of NET1
19	Length of this block
1D	Road definitions offset multiplier (power of 2)
1E	NET2 Segmented Roads
22	Length of this block
26	offset multiplier (power of 2)
27	NET3 Sorted Roads
2B	Length of this block
2F	Sorted roads record size

NET1

We've already discussed how highways can have up to 4 labels. The following table shows a 'typical' road definition entry in NET1 ; the length of each record varies depending on number of labels,number of subdivisions the highway is plotted and whether it has address information.

Items	Bytes	example
labels	3 per label	12 00 00 , 45 00 00, 24 01 81
Road Data	1	&44
Road Length	3	32 01
RGN_index_overview	1 per record	1,81 (2 records)
Highway pointer	1	01 05 , 01 06
Subdivision number	2	
House_number blocks	1	Set if bit 4 or Road Data is set
Street Address info block	varies	
NOD length of pointer	1	1 or 2
NOD2 offset	2 or 3	2 or 3 of NOD length or pointer=2

Example:

37	00	47	41	52	4D	49	4E	20	4E	45	54	01	00	DB	07	7 GARMIN NET
09	1E	07	15	06	37	00	00	00	24	00	00	00	00	5B	00	
00	00	00	00	00	00	00	5B	00	00	00	06	00	00	00	03	
00	00	00	00	00	01	00	60	00	80	44	06	00	00	01	81	
01	06	00	01	05	00	01	00	00	68	00	80	44	0B	00	00	
01	81	02	06	00	02	05	00	01	07	00	12	00	00	00	00	

Image shows 2 highways in NET1

	Highway 1	Highway 2
LBL	60 00 80	68 00 80
Data	44	44
Length of Road	06 00 00	0B 00 00
RGN	01 81	01 81
Record 1	01 at subdiv 6	2 at subdiv 6
Record 2	01 at subdiv 5	2 at subdiv 5
Length of pointers	1 ie 2	1
Pointer to NOD 2	00 00	07 00

Notice how 3 byte records 1 and 2 follow each other after 00 81

Data 44 means : has NOD info and has bit 2 set , see Mechalas Route definitions

In NOD 2 at offset 00 00 I find: a seven byte record

17 00 00 00 02 00 03 and

17 22 00 00 03 00 07

The first byte refers to the speed class and road type – see Mechalas

&17 is &10 + &7 ; the when translated gives me a max speed of 35 mph with a road type=1

Te next three bytes are offsets from NOD1 , ie 00 00 00 and 22 00 00

This is followed by 3 bytes giving information about the number of routing nodes in a highway.

Length of highways

Unlike stated by Mechalas ,you double the value to obtain length in metres.
So the first hw was 06 00 00 which gives you a value of 12 metres and the second, 0B 00 00, produces a value of 22 metres. These values together with the max speed can be used to calculate ETA.

NOD subfile

Mechalas offers some valuable information regarding the NOD subfile, but unfortunately a lot of its structure remains unclear.The NOD subfile is as the name implies about nodes and how they are linked ;it only exists if the IMG is routable. I am grateful to Robert Vollment for additional pointers regarding the NOD file structure although my findings differ in many respects.

NOD 1

NOD 1 contains information about nodes, linked directly or indirectly. Some of it still seems unclear .

NOD 1	Node records Block 1	
	Table Header	Details of size of each table
	Table A	Road segments
	Table B	Inter area links
	Table C	restrictions
	Block 2 ,3,4 etc	
NOD 2		
NOD 3		Boundary nodes

The structure is quite complex; within NOD1 there are , depending on the number of nodes, various 'green' blocks, following each other .

Each records block is often terminated by so called boundary nodes – these are used as links to other IMGs.

Finding the length of each record can be quite challenging.

We can ascertain where records start from offsets found in NOD 2 and NOD 3 .

The header of each record begins with a pointer to other tables,ie A ,B or C.

pointer	Flags	coordinates	coordinates	linked highway nodes	Current highway nodes	Flags A	Flags B	
02	44	2E 70 FE	48 12 17	05	07	6D	29	

Pointer

The first byte points to the Tables Header – see below.

Flags at offset 1

There are several flags which are set to indicate special conditions

Mask	Purpose
0 x 4	
0 x 8	Marking a boundary
0 x 10	Marking a restriction
0 x 20	2 byte coordinates offsets instead of 3
0 x 40	Direct links
0 x 45	
0 x 50	

Any combination is possible but most frequently encountered are 44 or 4C

44= 40 + 4
4C = 40 + 4 + 8 , ie boundary nodes as found in NOD3

Direction Coordinates

These could be 2 or 3 bytes depending on Flag 0 x 10

Nodes Bytes

The two bytes after the coordinates indicate number of nodes in a highway as a multiple of 2 (?)
The first nodes byte contains the number of nodes (as a multiple) of a linked highway ,ie (5+1)/2=3

The second contains number of nodes in current highway: (7+1)/2 = 4

Flags A & B

Flag A is one byte and Flag B can be 2 bytes. Both also contain information showing bearings between nodes.

Flag A	
0 x 7	Destination Class
0 x 38	
0 x 40	Going Forward
0 x 80	New Direction

Flag B	
0 x 40	Inter area link
0 x 80	Last link

Tables Header

There can be several tables headers within NOD1.

An offset to a tables header is NOT found in the NOD header; instead it has to be calculated. Presumably, this is because of the overwhelming number of nodes an IMG may contain. Strangely each new 'green' block,except for the first one starts with a tables header.

To calculate the start of a tables header you need to add &40 to the end of a previous records block and then find the nearest multiple of &40

Example: end of node records block :1C76

1C76 +40 = 1CB6

The next multiple of &40 is: 1CC0 so it starts at 1CC0

This is a 9 byte header:

00	01	02	03	04	05	Table A	Table B	Table C
coordinates			Coordinates			number	number	number

Number indicates number of records found in each table. Because each table contains records of a fixed length we can calculate its total length and thus the beginning of the next node records block, if any

Table A

0x00	3	Bits 0-29: Pointer to NET; bit 30: no delivery; bit 31: no emergency
0x03	1	Road class : bits 0-3: road speed; 4: oneway; 5-6: road class; 8: toll
0x04	1	RoadID

Each record has fixed length of 5 bytes:

```
00 00 13 00 12 RoadID  = 18
00 00 13 00 20 RoadID  = 32
00 00 13 00 2C RoadID  = 44
01 00 13 00 3E
01 00 13 00 F3
00 00 03 00 32
00 00 11 00 44
```

NOD 2

It starts at NOD + &25 with length:NOD +&29
It does not appear to be accessed from any subfile.

0	1	2	3	4	5	6+
Road classification	Offset into NOD1			mask	Mask?	Node bitmap

Its length is generally 7 bytes but depends on the first and 'blue' mask byte.
If the mask's value is >8 then an extra byte is added for every multiple of 8.
In addition, if bit 8 of the first byte is set, extra bytes highlighted in grey are added– see below.

Examples:

```
17 00 00 00 02 00 03
03 25 59 DB 01 00 04
25 87 00 00 08 00 FF
8B 5C 01 00 08 00 FF 04 14
87 1D 2D 03 0B 00 FF 06 04 12
BB B0 5B 00 14 00 E3 F7 0F 0C 09 40 00 0D 0E
25 82 61 00 09 00 FF 01
03 3F 1A 00 12 00 FF FF 03
```

For road classification see Mechalas .

Notice how offsets into NOD1 can show masks in the 3rd byte, ie &DB - their significance is uncertain.

Byte 4 acts as a mask for byte 5 or 6,ie gives you the number of bits to consider when examining byte 5 (and?) or 6.

In our first example byte 6 contains 0x03 which in bits from LSB looks like 11000000.

The mask value (2) makes us consider only the first 2 bits, which could imply that this highway has at least 2 nodes connecting to other highways, both of them set.

05 00 1B : 11011000

This would tell us to count the first 5 bits; the idea is that a node will be ignored if a bit is not set,ie 0, so we skip node 3.

If this is true then the maximum number of nodes can only be 8; to overcome this an extra byte is added for each additional multiple of 8 – see last 2 examples

At present, the function of byte 5 is unknown but we surmise that the mask is 2 bytes long to allow for values >255

0	1	2	3	4	5	6+			
Road classification	Offset into NOD1			mask	Mask?	Node bitmap	04,08 ,0C		

If 8th bit is set then the value after 0C signifies the length of extra bytes needed using a simple algorithm: extra bytes = (value-1)/2

Example 0C 13 → (13 -1)/2 = 9

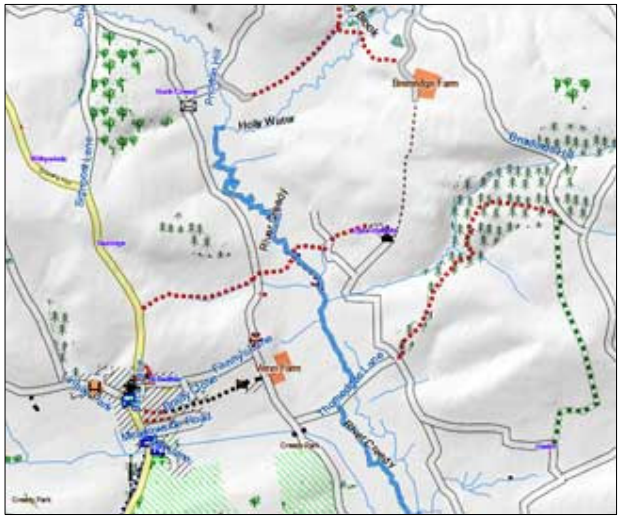
9B 13 08 00 13 00 7F FB 07 0C 09 42 00 28 30

A5 82 BE 01 17 00 F5 FF 7B 0C 13 41 00 15 16 17 18 19 1D 1E

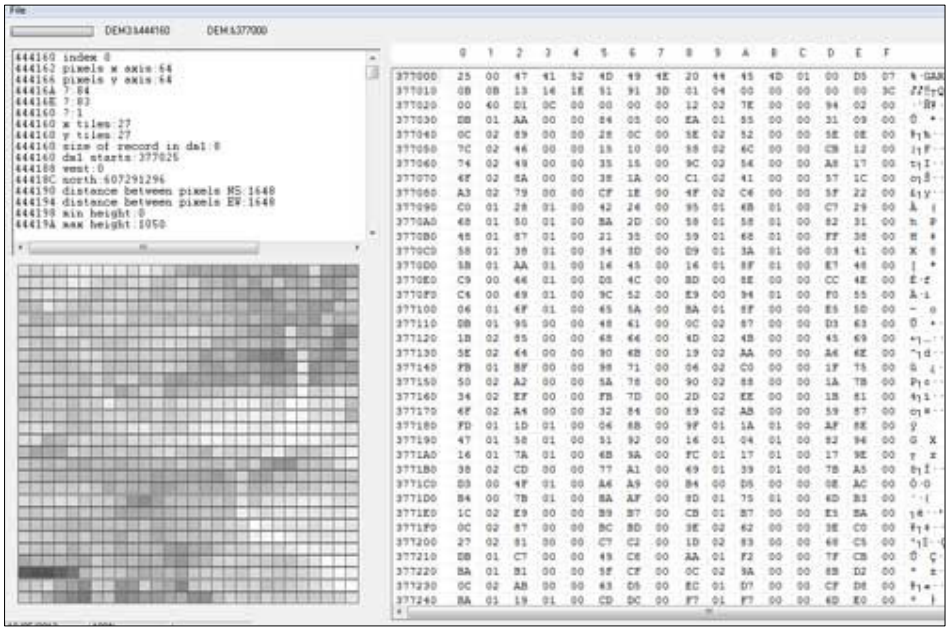
The 'red' bytes are always ordered according to size. It is not clear what they mean.

DEM subfile

Elevation data is found and plotted in the DEM subfile. For more information see:
Exploring_DEM.pdf



DEM Investigator is a GUI showing all known values including base heights for each tile.



Creating IMG files

There are several ways of creating an IMG file, each with its own personality:

1) using cgpsmapper

2) using MapTK

3) using mkgmap.jar

It all started with cgpsmapper, still in many ways the King , making full use of all the bitstream parsing options, but unable to cope with extended elements and latest developments. It uses 8 bit LBL encoding.

MapTK is quite a remarkable piece of software ; it produces IMG files from a text file and handles extended elements,using 8 bit LBL encoding. It is struggling to keep up to date but its IMG files are almost text book, ‘ ganz gründlich’ ie methodical.

By far the ‘neatest’ ,using fewer subdivisions and most up to date, is mkgmap created by a team of programmers ; its IMGs are a delight to parse and highly recommended.
6 bit LBL encoding is used.

None of them can parse DEM subfiles.

NT POIs

The structure of NT pois is basically understood and similar to non NT pois. The only difference is the data streams following the LBL / lat/lon blocks.

Such data streams *do not have fixed lengths* and Garmin is employing several tricks to define the various lengths - more information on

www.pinns.co.uk/osm/garmin.html.

Extra POI data stream

This consists of 3 or more bytes containing the ID as found in a TYP file - the maximum ID seems to be &FFFF.
Each of the 3 bytes include masks the purpose of which is not clear. This also makes it very hard to establish the extra poi ID.

IMG2TYP can display all IDs