



(51) **International Patent Classification:**
G08G 1/09 (2006.01) **G09B 29/10** (2006.01)
G01C 21/00 (2006.01)

(21) **International Application Number:**
PCT/EP2009/058131

(22) **International Filing Date:**
29 June 2009 (29.06.2009)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
61/129,491 30 June 2008 (30.06.2008) US
61/193,027 22 October 2008 (22.10.2008) US

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(81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States (unless otherwise indicated, for every kind of regional protection available):** ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report (Art. 21(3))

(54) **Title:** AN EFFICIENT LOCATION REFERENCING METHOD

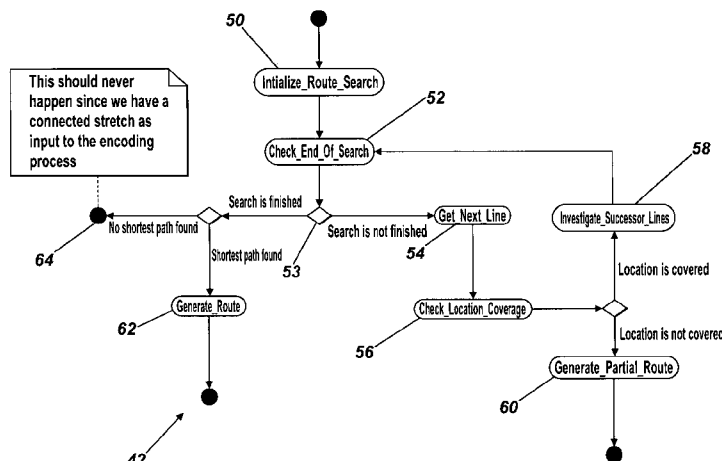


Fig. 4

(57) **Abstract:** A efficient method of encoding a continuous path within a road network is described. Ideally the path to be encoded is capable of being completely represented within a digital map and expressible as a path list of lines and/or segments existing in said digital map and consecutively ordered. The method comprises the steps of: (i) storing a start position in a route search list, said start position being one of: (a) the line or segment first appearing in said path list or, where the start node of said first line or segment is artificial, the first line or segment appearing in said digital map having a real start node and which leads directly to said first line or segment optionally through other artificial nodes, or (b) a most recently identified deviation line or segment also appearing in said path list; (ii) determining a path from the start node of the start position and including said start position to an end node of the last line or segment in the path list within said digital map, said path being determined according to an algorithm, (iii) comparing the shortest path so determined to the path list for identity, and in the absence of identity, identifying at least one deviation line or segment being part of the path list and having a start node representative of an intersection in said digital map but not being the line or segment first appearing in said path list, and if such deviation line or segment does not terminate at the end node of the last line or segment appearing in the path list, repeating step (i) using said deviation line or segment, and (iv) Storing the last line or segment in the path list in said route search list if not already stored. Most preferably, the algorithm used is a shortest path algorithm.



An Efficient Location Referencing Method

Field of the Invention

The present invention is concerned with an efficient map map agnostic on-the-fly location
5 referencing method. More particularly, the method is embodied in a location encoding
method which, although involving as a prerequisite a digital map such as those produced
and sold by companies such as Tele Atlas B.V. and Navteq Inc., is ultimately map-agnostic
in that the particular version or type of digital map used is not fundamentally important to
the resulting encoded description of the physical location.

10

In the interests of clarity, the term "location" as used hereinafter is to considered as
encompassing a variety of different physical, real-world features such as a point location
on the surface of the earth, a continuous path or route, or a contiguous chain of such, of
navigable thoroughfares existing on earth, or an area or region on earth capable of being
15 defined by two (in the case of a rectangular, square or circular area), or more parameters.
More succinctly, a location is a simple or compound geographical object. However, this
invention is most applicable to an efficient, machine-readable representation of a path
through a network of roads or other navigable thoroughfares represented in a digital map.

20 Background to the Invention

Geocoding is a known technique whereby a human referencing system for physical
locations, such as a street address, country and/or postcode is converted into associated
geographic coordinates, e.g. latitude and longitude. Various different geocoding systems
currently exist and rely, at least to some extent, on a geographic information system (GIS)
25 in which the street network is already mapped within the geographic coordinate space.
Inverse geocoding is the reverse process.

Any modern digital map (or mathematical graph, as they are sometimes known) can be
considered as a GIS, and in a most simple form is effectively a database consisting of a
30 plurality of tables defining firstly nodes (which can be considered as points or zero-
dimensional objects) most commonly representative of road intersections, and secondly

lines between those nodes representing the roads between those intersections. In more detailed digital maps, lines may be divided into segments defined by a start node and end node, which may be the same in the case of a segment of zero length or a looped segment (in which case the segment has a non-zero length), but are more commonly separate.

5 Nodes may be considered real or “valid” for the purposes of this application when they represent a road intersection at which a minimum of 3 lines or segments intersect, whereas “artificial” or “avoidable” nodes are those which are provided as anchors for segments not being defined at one or both ends by a real node. These artificial nodes are useful in digital maps to provide, among other things, shape information for a particular
10 stretch of road.

In this manner, nodes, lines and segments can be used as a means of completely describing a road network, and each element in the database is further defined by various attributes which are again represented by data in the tables of the database, e.g. each node will
15 typically have latitude and longitude attributes to define its real-world position. The complete “graph” of the road network is described by millions of nodes and segments to cover an area of spanning one or more countries, or part thereof.

Although practically all modern digital maps involve a structured definition of nodes and
20 segments, the actual manner in which this is effected between digital map providers varies enormously. For instance, each map vendor (and possibly each map version) may use unique IDs for each map element, whether node or segment. Therefore, even simple geocoding and inverse geocoding is possible only with some knowledge of the underlying structure of the database in which the requisite digital map is embodied. More simply, a
25 query designed to extract a street address from one digital map database based on latitude and longitude will not necessarily work on another – it may need re-casting as appropriate for the particular digital map database in question. This can also be true for different versions of a digital map provided by the same vendor.

30 One particular attribute often included in digital map databases is a Traffic Message Channel (TMC) location table reference. TMC is a technology for delivering traffic and

travel information to vehicle users, and more particularly to navigation systems (either portable or integrated) present within those vehicles and which include some form of digital map. A TMC message consists of an event code (which need not be traffic-specific, although these are most common) and a location code, often consisting of an ordered list
5 of location references by means of which the location of the traffic event can be determined in the digital map and thus represented graphically on the screen of the navigation system. A number of pre-defined nodes in the digital map are assigned a TMC location reference which is determined with reference to a limited location table. The location table consists of 2^{16} (65536) location references corresponding to a similar
10 number of physical or real world locations, usually road intersections, also identifiable in the digital map.

Although TMC messages are very efficient in that they can be as short as 37 bits in length and therefore do not impinge significantly on available bandwidth for broadcast data, only
15 a fixed number of location references are available, and therefore typically only motorways and major highways (or intersections thereon) in each country offering TMC can be referenced. There are various other disadvantages of TMC location references. For instance, TMC location tables are

- often maintained through a public authority or National Government,
- 20 - prone to change between update cycles, which are traditionally quite long,
- non-existent, or available only commercially, in some markets.

As it is becoming possible to identify traffic build up on secondary and urban roads using GSM and GPS probe data (e.g. vehicles users increasingly possess either a mobile phone or a connected satellite navigation devices useful as probes), a more expansive referencing
25 system is required.

One attempt to overcome some of the drawbacks of TMC location references or map-specific references is the Dynamic Location Referencing project, also known as AGORA-C
30 (in the process of standardization under no. ISO 17572-1,2, and 3). Although a complete

description of the AGORA-C location referencing approach is beyond the scope of this application, the fundamentals of the approach are that a location reference can be completely specified by a set of location points, specified by coordinate pairs of latitude and longitude and ordered in a list, each point complying with various rules but most importantly being consecutive in terms of the location being referenced and the previous point in the list, i.e. successive points form a next-point-relationship. As with other location referencing systems, each point is provided with a number of attributes which assist in better defining that point, but specific to the AGORA-C method is the identification of each point as one of a location point, an intersection point, a routing point, or some combination of these three. Each point along the location at which the road section signature changes is represented by an intersection point, so locations being paths over a road network and which pass through intersections without any road section signature change need not be referenced by an intersection point. For example, if a location includes a section of motorway which includes junctions that are not relevant as far as the location is concerned, then there is no need to include intersection points for such junctions.

One of the earlier steps in the AGORA-C encoding method is the determination of all intervening intersection points between a first and a last intersection point along the location at which a change of road section signature occurs. All these points are added to a table of points ultimately forming part of the AGORA-C location reference. Within this table, at least two routing points will also have been identified, again according to certain rules. Routing points are points used to reconstruct the location (in a decoding operation) by route calculation and are provided only where road segments having a routing point bearing attribute are longer than a certain length. During the encoding process according to the AGORA-C standard, a determination is made as to whether intermediate routing points are required to calculate a route from the first identified routing point to the last identified routing point. This determination is made using a weighted shortest path algorithm— if it is determined that additional routing points are required, then these are also added to the pre-existing table of intersection points, but only in instances where such points do not coincide with the previously identified intersection points. In this latter case, a simple attribute change is required to ensure that the pre-existing intersection point is

also identified as a routing point. Although in most cases, no additional routing points may be required, it is to be noted that the effect of the weighted shortest path algorithm as applied in AGORA-C is to potentially increase the number of points required, as opposed to reducing the number of pre-existing intersection points by which the location is at first
5 specified.

Although this referencing approach is comprehensive in that it is possible to accurately and repeatably encode and decode any location existing within a geographical information system, it is believed that that the system is excessive and possibly redundant in certain
10 aspects, and a more efficient encoding system is possible. For instance, although the referencing method is independent of any pre-compilation work and is map-independent, the average AGORA-C message size is significantly higher than 30 bytes per location reference which may be problematical if not prohibitive in the modern climate of highly congested transmission frequencies and the increasingly restricted bandwidths associated
15 therewith, particularly as regards mobile/wireless devices to which it may be desired to transmit such information.

It is therefore an object of this invention to provide an efficient and compact format for a location reference which:

- 20 - is more efficient than AGORA-C without significantly compromising on accuracy,
- is not prejudicial to available bandwidths for broadcast data ,
- is capable of accounting for differences in the underlying digital map (or differences between versions thereof) used in creating the reference
- can be a complete substitute for the TMC location referencing system
- 25 - is capable of addressing the entire road network including urban and low-level roads of any country for which a digital map is available, and
- does not require periodic maintenance.

Summary of the Invention

A method of encoding a continuous path within a road network, said path being completely represented within a digital map and expressible as a path list of lines and/or segments existing in said digital map and consecutively ordered, said method comprising the steps of:

- 5 (i) storing a start position in a route search list, said start position being one of:
 - the line or segment first appearing in said path list or, where the start node of said first line or segment is artificial, the first line or segment appearing in said digital map having a real start node and which leads directly to said first line or segment optionally through other artificial nodes,
 - 10 - a most recently identified deviation line or segment also appearing in said path list,
- (ii) determining a path from the start node of the start position and including said start position to an end node of the last line or segment in the path list within said digital map using an algorithm,
- (iii) comparing the shortest path so determined to the path list for identity, and in the
15 absence of identity, identifying at least one deviation line or segment being part of the path list and having a start node representative of an intersection in said digital map but not being the line or segment first appearing in said path list, and if such deviation line or segment does not terminate at the end node of the last line or segment appearing in the path list, repeating step (i) using said deviation line or segment, and
- 20 (iv) Storing the last line or segment in the path list in said route search list if not already stored.

Preferably, the algorithm used to determine the path between start position and the end node is a shortest path algorithm, but other algorithms might also be employed, provided
25 such are reversible in that a path so determined can be decoded using the corresponding reverse algorithm.

Preferably, the method includes performing one or more of final concatenation, conversion, transposition, and validity operations which result in a valid, ordered list of
30 location reference points as hereinafter described, or a machine-readable representation thereof.

In a second aspect of the invention, there is provided a computer program element comprising computer program code means to make a computer execute the method as set out above. In a yet further aspect, there is provided such a computer program embodied
5 on computer readable medium.

Preferably, in the case where the start and/or end of the continuous path desired to be referenced do not coincide with a real node in the digital map, the preliminary validity check includes extending the start and end points of the continuous path such that they do
10 coincide with real nodes appearing in the digital map, and storing an offset to represent the distance in advance or behind said real nodes that the continuous path actually commences or terminates.

Further preferably, the encoding of a continuous path is further enhanced by storing each
15 continuous path which is successfully encoded in a database, and for each subsequent continuous path desired to be encoded, querying said database to establish whether that subsequent continuous path, or a portion thereof, has been previously encoded. Additionally, if that subsequent continuous path forms part of a larger, previously encoded continuous path, then further efficiencies may be realised in the encoding process by use
20 of said database. Furthermore, it may also be possible to store continuous paths in said database for which encoding failed, and for the encoding process to be halted well in advance of attempting to encode subsequent continuous paths being identical to or forming part of such continuous paths.

25 Other features of the invention are described hereinafter and additionally in the claims appended hereto.

In contrast to the AGORA-C method for creating location references, the present method actually seeks to reduce the requisite number of location reference points appearing in a
30 location by means of a simple shortest path algorithm. As mentioned above, the AGORA-C approach uses a weighted shortest path to determine where additional routing points

should be inserted in an already comprehensive list. Furthermore, this weighted shortest path algorithm is employed primarily to avoid short detours on lower class roads which may run parallel to more arterial highways.

- 5 The present invention realises that a simpler algorithm employed on a more universal basis as opposed to a very specific situation can result in a far a simpler, and thus quicker (in terms of encoding time) approach. The resulting location reference is far more efficient, in terms of the number of location reference points required to completely reference the continuous path. In particular, although the location reference resulting from the present
- 10 invention is derived from a pre-existing complete list of segments and/or lines, it bears very little resemblance thereto as the output of the method is to provide a minimal list of points from which the continuous path so referenced can subsequently be reconstructed in a decoding operation.
- 15 For instance, it is certainly possible that a continuous path of many kilometres, represented initially by many consecutive nodes, segments or lines in the digitally mapped road network, may be represented by only two location reference points, if the shortest route between the start point and end point of that path over the road network as represented by said digital map actually coincides with the continuous path over its entire
- 20 length. However, the present invention does consider an arbitrary imposition of, preferably, a 15km limit between location reference points.

A further realisation made in the present invention is that by initially starting with a list of segments or lines, as opposed to the AGORA-C method of initially representing the

25 continuous path by a list of location, intersection and/or routing points, useful efficiency can be achieved during the algorithmic reduction of such a list to location reference points

Experiments using the encoding method of the present invention have shown that an average message size for typical available traffic feeds of around 18 bytes is consistently

30 achievable for a wide variety of different locations or continuous paths within road

networks. Compared to the 30+ bytes of an AGORA-C location reference message, this represents a significant reduction.

Such reduction can be achieved not only by virtue of the referring to a location in terms of
5 a sum or concatenation of partial shortest paths through the network, but also as a result
of reduced attribute data which is required for each location reference point forming part
of the location reference. These reductions will become apparent in the following
description of the physical and logical data formats employed by the invention.

10 A specific embodiment of the invention will now be described by way of example with
reference to the accompanying drawings wherein:

Brief Description of the Drawings

Figure 1 shows an overview schematic flowchart of the encoding method,

15 Figure 2 shows a schematic flowchart of the validity check first performed as part of the
encoding method,

Figure 3 shows a schematic flowchart of the iterative part of the encoding method
including a shortest path route search function,

Figure 4 shows a schematic flowchart of the shortest path route search function in greater
20 detail,

Figure 5 shows a schematic flowchart of the procedure involved in determining that
whether the location desired to be encoded is being correctly covered by the shortest path
route search,

Figures 6, 7 and 8 graphically illustrate the different possibilities occurring in checking that
25 a location is being correctly covered by the procedure illustrated in Figure 5,

Figures 9, 10, 11, and 12 provide schematic representations of a digital map including
nodes and segments and in particular Figure 9 illustrates an example network, Figure 10
illustrates a location path desired to be encoded within that network, Figure 11 illustrates
the shortest path between start and end nodes of an extended path including that
30 location, and Figure 12 illustrates the location reference points required to completely
reference that location, and

Figures 13-21 provide various schematic illustrations useful in the context of the logical data format, described below, and specifically, Figure 13 shows the required consecutive connection of location reference points (LRPs), Fig. 14 illustrates how a bearing is calculated for one LRP, Fig. 15 shows how bearings can vary in a positive sense only, Fig. 16 demonstrates how a "distance to next point" attribute may be determined for a LRP, and further demonstrates which LRP that attribute relates to, Fig. 17 illustrates the use of offsets, Fig. 18 shows the manner in which LRPs are provided with attributes, Figs. 19/20 illustrates nodes to be avoided during the determination of a location reference, and Fig. 21 illustrates how bearing values for a LRP fall within 1 of 32 discrete sectors of a circle.

10

Detailed Description

The following description of the invention is provided in terms of segments, but it is to be understood that the method can be applied equally to lines, or to combinations of lines and segments which together are representative of a continuous path through a road network.

15

Referring firstly to Figure 1, and as previously mentioned, it is possible to store complete location references having previously been successfully encoded according to the present invention in a database, and therefore in Figure 1 at step 10, a check is made of such database to establish whether the location desired to be encoded has already been encoded. If so, then the previously encoded location can be retrieved from the database, without any further processing.

20

If the location is not present in the database, then a validity check 14 is performed on the location and its constituent segments to determine whether the location meets certain criteria hereinafter described, and provided that the location is valid, the location reference is created at step 16. If either the validity check, or the creation of a location reference for that particular location fails, then such failure may also be stored in said database as indicated in step 18.

25

30

As final steps in the process, the location reference created at 16 is further checked for validity in step 20. Step 22 is illustrative in that it signifies conversion from one representation to another. Ultimately, the conversion process (which may include one or more intermediate formats) results in a wirelessly transmissible and machine readable binary representation as prescribed in a physical data format such as that hereinafter described. This format may take another form, such as XML or indeed any other mark-up or machine-readable representation useful in transferring information between an encoder and decoder, and the present invention is not to be considered limited to the specific format described. Thereafter, the complete, accurate and correct representation of the location can be stored in said database, as indicated in step 24.

Referring to Figure 2, the "Check_Location" validity check process illustrated at 14 in Figure 1 is further described. All locations which are not stored in the database of previously encoded locations need to be checked for validity before further processing. As a first step, at 30, a connectivity check is performed. The check of the connectivity ensures that the incoming location is not split up into two or more different stretches which are not connected. Each connected stretch needs to be handled separately and represents one location to be encoded in its own right. This check is passed if the location consists of only one connected stretch.

At step 32, a functional road class check is performed. This check ensures that all of the segments forming part of the initial location meet a minimum functional road class as defined in the underlying digital map. The functional road class (FRC) is a common attribute of lines or segments in map data and indicative of a relative importance of a particular type of road. An arbitrary decision to include only functional road classes from 0-7 has been made, as this effectively precludes any non-navigable roads, or roads of a very low category on which traffic events would be most unlikely ever to occur.

In one embodiment, the encoder can be enabled to check whether the location is affected by turn restrictions or not. If enabled, then the location will be investigated step by step, as indicated at 34, if there is a turn restriction along the way. Every turn from segment to

segment needs to be valid. If not, an exception will be thrown at 39 and the location will not be encoded. It is worth mentioning here that the turn restriction check need not be enabled, and the method will continue to encode locations successfully for the vast majority of locations. However enabling a turn restriction check as described merely acts
5 as an extra means of ensuring successful encoding.

As final steps to the validity check of the location, a determination is made as to whether the start node of the first segment in the location and the end node of the last segment in the location are real nodes, as opposed to being artificial or avoidable nodes. To explain
10 further, segments in most instances tend to be artificial constructions and arbitrarily defined by the map vendor. Nevertheless they do provide much greater resolution compared to lines as regards describing traffic events on real-world sections of road where the traffic event begins at some arbitrary point along a particular road section. In the context of a motorway or major highway, a traffic event may occur at some point between
15 two intersections (represented by real nodes) located a significant distance apart (e.g. 15km or more), and therefore the exact point at which a traffic situation exists is much more likely to be close to an artificial node than it is to a real node. However, the probability of having such artificial nodes in the decoder map is very small, so these artificial nodes are to be avoided. This is done by extending the location uniquely at its
20 start and end to real nodes appearing in the underlying digital map, and an offset distance value is provided as an attribute to such nodes so that the exact position of the traffic (or other) event, i.e. the correct start of the location to be encoded, can be correctly referenced. Therefore, the location can be described precisely by using a path which covers the location completely and offsets. Having a longer path covering the location also allows
25 for the possibility of re-using the location reference path and merely updating the offsets, which will save bandwidth and time.

Accordingly, if the start node is not artificial then there will be no extension. Otherwise the incoming segment to the first segment having the artificial start node is chosen as the new
30 start segment at step 36. If the start node of the new start segment is also artificial or avoidable then the procedure is repeated until a suitable start node is identified.

The second step 38 tries to extend the end of the location. This is done in much the same way as for the start segment except that the end node of the last segment is assessed, and a search made for outgoing road segments. If in either of these two steps, an artificial node cannot be extended and a real node found, then it is possible to continue with the method using the artificial node in the hope that it can be matched on the decoding side. Accordingly, the method is still valid, but the confidence level is lower.

Referring to Figure 3, a description of the Create_LocationReference step 16 in Figure 1 is provided. After the validity processing described above, a valid sequence of segments is provided, and this is desired to be converted into a location reference as a tree of objects defined in a logical data format, as hereinafter described.

The first step 40 in the generation of a location reference according to the present invention is to identify the first segment at which the route search should commence.

Thereafter, a route search is performed at step 42 using either the first segment or an intermediate or deviation segment. The route search is a shortest path route calculation between the first (or intermediate) segment and last segment of the location. The specifics of route search are described in greater detail with reference to Figure 4.

The route search calculates a shortest path between the start segment and the destination segment. This calculation is done iteratively, and after an initialization at step 50, the main loop including steps 52, 54, 56, 58 will calculate a shortest path. The shortest route path will be checked every iteration at step 56 (described in greater detail hereinafter with reference to Figure 5) to establish whether the location is still part of the calculated shortest-path tree or not. If the location is not covered by the shortest-path tree anymore then the route calculation stops and returns a partial route (the part of the location which is covered so far) at step 60 and a segment which shall be used as intermediate location reference point to make the route search unique, and capable of being continued thereafter. This intermediate segment is identified at step 44 in Figure 3 and returned to

the route search algorithm as the new start segment from which one or more further route searches are to be conducted.

5 Ideally the route search will focus on the part of the location which is not extended as described above as the extended parts of the location will not have any influence on the route calculation because there is no deviation from this path possible. The extensions may be added to the location reference in a later step.

10 At step 50, the route search is initialized and all data structures are reset. At step 52, and decision point 53, a check is made as to whether the route search must be continued or can be stopped. The search can be stopped if

- the shortest-path between the start segment and destination segment is found, in which case a shortest path route can be generated as indicated at 62,
- there are no more segments to process which means that there exists no route
15 between the start segment and destination segment, as indicated at 64,or
- If an intermediate segment is identified.

In all practical cases, a route should always exist because the path itself is valid and forms such a route but this check is compulsory for every route search algorithm. In the case that the search is not complete, at step 54, the Get_Next_Line procedure fetches the best line
20 from what is often called an "open-list" being a list of all those lines forming part of the shortest path between two relevant nodes. As a consequence of the shortest path algorithm, the shortest path to a line is finalised with the departure of a line forming part of the location from one being present in the open-list as retrieved at step 54. Accordingly, The "Check_Location_Coverage" step 56 is outlined in greater detail with reference to
25 Figure 5, but briefly this step checks if this condition is fulfilled during the route calculation. Checking during the route calculation means that every fixed segment (a segment is fixed if the shortest path thereto has been finally determined) will be investigated if it also forms part of the location. If the segment currently under consideration forms part of the location desired to be referenced, then a check is made to establish that the beginning part
30 of the location is completely included in the current shortest-path tree. This means that the calculated shortest path to the last location segment needs to be the location itself. If

any deviation is encountered, the route calculation is stopped and a partial route is generated at step 60 and returned to the route search process illustrated in Figure 3. In step 44 of this figure, an intermediate segment is identified in the underlying digital map, and route search is re-started using this intermediate segment as the start point.

5

There are various different possibilities for correctly identifying and referencing the intermediate segment depending on the nature of the deviation which appears in the shortest path calculation, and these are all described with reference to Figures 5, 6, 7, and 8.

10

To check coincidence of the shortest path thus far determined, the last segment found on the location during the route search is stored in a route search list (indicated at 70 in Figure 5) so that it can easily be determined which segment should come next, as only subsequent segments contiguous with the last stored segment, or at least having coinciding end and start nodes respectively, can be considered. It is fundamental to the economy of location reference length that the shortest path route search effectively eliminates those segments from the reference which fall on the shortest path, i.e. there is no need for them to form part of the reference. Accordingly, at decision points 72, 74, checks are made that the most recent segment forming part of a shortest path route list both exists or coincides with the location being encoded, and is correctly referenced as far as the shortest path is concerned in terms of pointers which are ideally used in the shortest path list to refer to:

15

- the next expected segment on the shortest path, and
- the previous segment on said shortest path.

20

Provided that both these pointers reference segments which are also on the location path, then the location is considered precisely covered by the shortest path and the route search can continue.

25

Of course however, shorter deviations will inevitably be found, and all possible deviation types are covered by the various branches of the flowchart of Figure 5, and the simple line

drawings of Figures 6, 7, and 8. Most simply, a deviation is found if a segment on the location path is currently being analysed but this segment is at odds with the next expected segment as far as the shortest route list is concerned. A deviation is also found if the next expected segment of the shortest route list is in conformity with the next segment in the location path list, but the predecessor pointer for this segment in the shortest path list does not point to the location. This means that the predecessor pointer needs to be equal to the last segment found on location. In both cases it is necessary to identify a proper intermediate. The following steps determine this intermediate and in a special case it is necessary to add two intermediates. The main focus on finding a proper intermediate is that we use a segment having a start node being part of an intersection.

Referring firstly to Figures 5 and 6, it is in all cases necessary to find the start of the deviation, indicated at 76. Figure 6 illustrates the simplest case in which the deviation starts before the last segment stored as part of part of the shortest route list and also forming part of the original location path list. The total location path to be described is represented by segments A, B, C, D, E, F and G. The shortest path thus far determined with certainty and coinciding with the location is represented by the segments A and D, emboldened in the Figure. As the shortest path search progresses, particularly as between the start segment A and the end node of segment E, a deviation H is found which is shorter. In such a case (which will be the most common case), ideally it is desired to find the segment appearing on the location and having a start node at which the deviation starts. In this case, segment C is required to be included as the proper intermediate as this ensures that the location is followed in any shortest path algorithm conducted in a decoding process. This search effectively recurses through the location path list for segments that meet this criteria, and this is referenced at 78, 79 in Figure 5. Although not possible in terms of the simple path shown in Figure 6, it is possible that no such segment may be found. In this case, the segment last stored in the shortest route list can be used as the intermediate, as illustrated at 80 as a shortest path function using the last stored segment as its start will never identify any deviation originating before it.

30

In an alternative embodiment, the deviation originates after the end of the last segment stored in the route search list E, as emboldened in Figure 7. In this case the shortest path from A to E is known, and only segments between A and E have been stored. The shortest path between segment A and the end node of segment F can actually be referenced by only A and I, the latter being a deviation from the location path which includes F and occurring after the end of the last stored segment E. In this case, the intermediate can be created from that segment F, as indicated at 82 in Figure 5, provided that the predecessor pointer for segment F actually points back to a segment on the location, in this case E. This check is indicated at 84.

10

In the exceptional case in Figure 8, where the predecessor pointer for a deviation occurring after the last segment stored as part of the shortest route search actually refers back to a segment not forming part of the location, as in the case of the segment K referring back to segment J, then as a first step, a first intermediate segment E is created (as in 82 previously discussed), and a second intermediate segment D is also stored as this is the last segment occurring on the location path and beginning with an intersection from which the shorter path segment J originated. These steps are indicated generally at 86, 88 in Figure 5, and are necessary because the stored location reference must ultimately avoid both segments J and K.

20

Referring finally back to Figure 3, once the processing of the entire location path list is complete, then all the partial shortest paths identified are combined at step 46. The coverage of the location may consist of several calculated partial routes if the initial route calculation determines an intermediate segment. This intermediate segment acts as additional information in the location reference in order to guide the route search for a complete coverage of the location. If the route search reaches the end of the location all calculated partial routes will be combined to form a path which covers the location completely. This step may in one embodiment also add the expansions at the start and the end of the location as calculated in steps 36, 38 illustrated in Figure 2. The first and last location reference points will be adjusted and new offsets describing the relative position of the original location are calculated.

30

To provide a better understanding of the manner in which a location is encoded using the present invention, a further specific example is provided with reference to Figures 9, 10, 11 and 12.

5

An encoder map is shown in Figure 9 and consists of 15 nodes and 23 lines (two-way lines are counted twice). The nodes are numbered from 1 to 15. The necessary line attributes are shown beside every line using the format: <FRC>, <FOW>, <Length in meter>. FRC is an abbreviation for "Functional Road Class" and FOW is an abbreviation for "Form of Way", both of which are described in greater detail below. The arrowheads indicate the possible driving direction for each line.

10

The location to be encoded is shown in Figure 10 using bold lines. The location starts at node ③ and continues over the nodes ⑤, ⑦, ⑩, ⑪, ⑬, ⑭ and ends at node ⑮. Its total length in the encoder map is 685 meters. The ordered list of lines and the map to be used during encoding serves as input for the encoder.

15

Encoding:

In the first step of the encoding process the location will first be checked for validity. Since the location is connected and drivable and all functional road classes along the location are between 0 and 7, this location is valid. Turn restrictions are not included in the map data and therefore the encoder can ignore this check.

20

The encoder second step is to check the start and end node of the location as being real nodes according to certain predetermined data format rules. The end node ⑮ has only one incoming line and is therefore valid. The start node ③ also has two incident lines but here it is one outgoing and one incoming line. Therefore this node is not valid and the encoder searches for a real node outside the location. The encoder will find node ① to be a real node and it also expands the location uniquely. Node ① is chosen as the new start node for the location reference and there will be a positive offset of 150 meters. The total length of the location reference path results in 835 meters.

25

30

The third step of encoder is to proceed to calculate a shortest-path between the start line (in this case, the line between nodes ① and ③); however, in common usage, the shortest path may be calculated without extensions) and the end line (line between nodes ⑭ and ⑮) of the location. The resulting shortest-path is outlined in Figure 11 using bold lines.
5 The shortest-path has a length of 725 meters.

The next (4th) step of the encoding process is now to check whether the location is covered by the calculated shortest-path. It will determine that this is not the case and there is a
10 deviation after node ⑩.

According to the principles outlined above, the encoder will determine the line from node ⑩ to ⑪ as becoming a new intermediate location reference point. Node ⑩ is a real node since it cannot be stepped over during route search and the shortest-path to this line
15 covers the corresponding part of the location completely. The length of the location being covered after this first shortest-path calculation is 561 meters.

The next encoding step prepares the route calculation in order to determine a shortest-path for the remaining part of the location (from node ⑩ over ⑪, ⑬ and ⑭ to ⑮).
20 The shortest-path calculation will therefore start at the line from ⑩ to ⑪ and ends at the line from ⑭ to ⑮.

The encoder returns to step 3 above and will determine a shortest path (length: 274 meters) between ⑩ and ⑮ and step 4 above will return that the location is now
25 completely covered by the calculated shortest paths.

As a next step, the location reference path will be composed of the two shortest-paths and the ordered list of location reference points will now be formed. Figure 12 shows the lines in bold which are selected for the location reference points. The first location reference
30 point points to the line from node ① to ③ and indicates the start of the location reference path, the second location reference point points to the line from node ⑩ to ⑪

and this line was necessary to avoid the deviation from the location. The last location reference point points to the line from node ⑭ to ⑮ and indicates the end of the location reference path.

- 5 The penultimate step is a check of the validity of the location reference. Since all lengths between two subsequent location reference points are less than the maximum distance, the location reference is confirmed as being valid.

10 The final step is the conversion of the ordered list of LRPs into a Binary location reference, and the following description of both the Logical Data Format and Physical Data Format as prescribed by the applicant will assist in the understanding of how this is achieved. It is to be emphasised that the following description providing details of the specific formats is provided only as an example, and the skilled reader will appreciate that other formats are possible.

15

SPECIFICATION for LOGICAL DATA FORMAT & PHYSICAL DATA FORMAT

The following table explains common terms and abbreviations used in this document and in the context of location referencing:

Abbreviation	Description
AF	Attribute Flag – a flag which indicates that the binary representation of the location reference includes attribute information
ArF	Area Flag – a flag which indicates that the location reference describes an area
BEAR	Bearing – angle between the direction to a point in the network and a reference direction (here: the true North)
COORD	Coordinates – a pair of two values (longitude and latitude) representing a position in a two-dimensional network
DNP	Distance to Next Point – the length in meter to the next location reference point (measured along the location reference path between these two LRP)
FOW	Form Of Way - Certain aspects of the physical form that a line takes. It is based on a number of certain physical and traffic properties.
FRC	Functional Road Class - A classification based on the importance of the role that the line performs in the connectivity of the total road network.
lat	Latitude – geographic coordinate used for north-south measurement
LFRCNP	Lowest Functional Road Class to Next Point
lon	Longitude – geographic coordinate used for east-west measurement
LRP	Location Reference Point – a point of the location which holds relevant information enabling a map-independent location reference; typically

	a collection of information describing an object in the map; consists of a coordinate and additional information about a line in the map.
NOFF	Negative Offset – distance in meter along the location reference path between the real end of the location and the end of the location reference path
NOffF	Negative Offset Flag – a flag which indicates that a negative offset is included in the location reference
POFF	Positive Offset – distance in meter along the location reference path between the start of the location reference path and the real start of the location
POffF	Positive Offset Flag – a flag which indicates that a negative offset is included in the location reference
RFU	Reserved for future use – a bit in a binary stream which does not have a use yet
VER	Version – Version information

Table A1: Explanation of common abbreviations

1. Data format

A location reference is a description of a designated part of a digital map or a sequence of
 5 geographical positions. For this description we use the model of location reference points (LRPs, see 1.1.1).

A location reference for line locations contains at least two LRPs but there is no maximum
 number of LRPs defined. The location reference path is the path in the digital map
 10 described by the LRPs and can be found by a shortest-path calculation between each consecutive pair of LRPs.

1.1 Logical data format specification

The logical data format describes the logical model for location references according to the MapLoc™ standard.

5 1.1.1. Location Reference Point (LRP)

The basis of a location reference is a sequence of location reference points (LRPs). Such a LRP contains a coordinate pair, specified in WGS84 longitude and latitude values and additionally several attributes.

10 The coordinate pair (see 1.1.3.1) represents a geographical position within a map/network and is mandatory for a LRP. The coordinate pair belongs to a “real” node within a network.

The attributes (see section 1.1.3.2 to 1.1.3.6) describe values of a line within a network at which the line is incident to the node described by the coordinate pair. In this context it is
15 not defined if the attributes refer to an incoming or outgoing line regarding the node. This will be specified in section 1.2.

1.1.2. Topological connection of LRPs

Referring to Figure 13, The location reference points shall be stored in a topological order
20 or “next point”-relationship of successive LRPs. The last point in this order will have no next point in this relationship.

Figure 13 shows an example of this relationship. The LRPs are indicated by A1, B1 and C1 and the black lines and arrows indicate the order of the points from A1 to C1 in the
25 location reference path. In this example the LRP A1 will have B1 as next point, B1 will have C1 as next point and C1 will have no next point.

1.1.3. Components of LRPs

This section describes the components of a location reference point.

1.1.3.1 Coordinate pair

Coordinate pair stands for a pair of WGS84 longitude (lon) and latitude (lat) values. This coordinate pair specifies a geometric point in a digital map. The lon and lat values are stored in a decamicrodegrees resolution (10^{-5} , or five decimal points).

Abbreviation: COORD

Type: (float, float)

1.1.3.2 Functional Road Class

The functional road class (FRC) is a road classification based on the importance of a road. The possible values of the FRC attribute are shown in Table A2. If there are more FRC values defined than these 8 location reference values then a proper mapping needs to be done or less important classes needs to be ignored.

FRC
FRC 0 – Main road
FRC 1 – First class road
FRC 2 – Second class road
FRC 3 – Third class road
FRC 4 – Fourth class road
FRC 5 – Fifth class road
FRC 6 – Sixth class road
FRC 7 – Other class road

Table A2: Logical format: Functional road class

Abbreviation: FRC

Type: integer

1.1.3.3 Form of way

The form of way (FOW) describes the physical road type. The possible values of the FOW attribute are shown in Table A3.

5

FOW	Description
UNDEFINED	The physical road type is unknown.
MOTORWAY	A Motorway is defined as a road permitted for motorized vehicles only in combination with a prescribed minimum speed. It has two or more physically separated carriageways and no single level-crossings.
MULTIPLE_CARRIAGEWAY	A multiple carriageway is defined as a road with physically separated carriageways regardless of the number of lanes. If a road is also a motorway, it should be coded as such and not as a multiple carriageway.
SINGLE_CARRIAGEWAY	All roads without separate carriageways are considered as roads with a single carriageway.
ROUNABOUT	A Roundabout is a road which forms a ring on which traffic travelling in only one direction is allowed.
TRAFFICSQUARE	A Traffic Square is an open area (partly) enclosed by roads which is used for non-traffic purposes and which is not a Roundabout.
SLIPROAD	A Slip Road is a road especially designed to enter

	or leave a line.
OTHER	The physical road type is known but does not fit into one of the other categories.

Table A3: Logical Format: Form of way

Abbreviation: FOW

Type: integer

5 **1.1.3.4 Bearing**

The bearing (BEAR) describes the angle between the true North and a line which is defined by the coordinate of the LRP and a coordinate which is BEARDIST along the line defined by the LRP attributes. If the line length is less than BEARDIST then the opposite point of the line is used (regardless of BEARDIST). The bearing is measured in degrees and always positive (measuring clockwise from North). The parameter BEARDIST is defined in Table A4.

10

Abbreviation: BEAR

Type: integer

Abbreviation	Description	Value	Unit
BEARDIST	distance between two coordinates which form a line for the calculation of the bearing value	20	metres

Table A4: Logical format: Parameter BEARDIST

15

Figure 14 shows how the second point for the bearing calculation is determined. The figure shows a line from A2 to B2 which is longer than BEARDIST. The shaded part of this line is exactly BEARDIST meters long so that the point marked with B' is BEARDIST meters away from A2 traversing along the line from A2 to B2. The straight line from A2 to B' is now considered for the calculation of the bearing value. Note, this is different to the angle that would have been calculated if the opposite node of line (in this case, this would be B2) is used.

20

Figure 15 shows two examples of the bearing value calculation. There are two lines, one from A3 to B3 and one from A3 to C3. For both lines the arcs indicate the angles to the North.

5

1.1.3.5 Distance to next LRP

This DNP field describes the distance to the next LRP in the topological connection of the LRPs. The distance is measured in meters and is calculated along the location reference path. The last LRP will have the distance value 0.

10

Abbreviation: DNP

Type: integer

Figure 16 shows an example of the distance calculation and assignment. The three LRPs are in a sequence from A4 over B4 to C4. Therefore the distance between A4 and B4 along the location reference path will be assigned to A4. The LRP B4 will hold the distance between B4 and C4 and the LRP C4 will have a distance value of 0.

15

1.1.3.6 Lowest FRC to next LRP

The lowest FRC (LFRCNP) is the lowest FRC value which appears in the location reference path between two consecutive LRPs. The highest FRC value is 0 and the lowest possible FRC value is valued with 7.

20

Abbreviation: LFRCNP

Type: integer

25 1.1.4. Offsets

Offsets are used to shorten the location reference path at its start and end. The new positions along the location reference path indicate the real start and end of the location.

1.1.4.1 Positive offset

The positive offset (POFF) is the difference of the start point of the location reference and the start point of the desired location along the location reference path. The value is measured in meters. Figure 17 shows an example for the calculation of the positive and negative offset. The lines are indicating the location reference path and the hatching indicates the desired location.

Abbreviation: POFF

Type: integer

10 1.1.4.2 Negative offset

The negative offset (NOFF) is the difference of the end point of the desired location and the end point of the location reference along the location reference path. The value is measured in meters. (see Fig. 16 also).

15 Abbreviation: NOFF

Type: integer

1.2 Relationship Attributes – LRP

All attributes are linked to a LRP. For all LRPs (except that last LRP) the attributes describe an outgoing line of the node at the LRP coordinate. The attributes of the last LRP direct to an incoming of the node at the LRP coordinate.

Figure 18 shows an example for the relationship between a LRP and the attributes. The lines indicate the location reference path and the nodes A5, B5 and C5 are the LRPs. Note that there is also a line whose start and end node is not a LRP (the third line in the sequence). This line does not need to be referenced because it is covered by the shortest path between the LRPs B5 and C5.

The LRPs A5 and B5 direct to an outgoing line and the last LRP C5 directs to an incoming line.

30

1.3 Data format rules

These rules describe additional regulations for location references according to this specification. These rules are used to simplify the encoding and decoding process and to increase the accuracy of the results.

5

Rule – 1 *The maximum distance between two location reference points shall not exceed 15km. The distance is measured along the location reference path. If this condition is not fulfilled for a location reference then a sufficient number of additional LRPs shall be inserted.*

10

The maximum distance between two consecutive location reference points is restricted in order to speed up shortest-path computation because several short routes can be computed quicker than one large route if the routing algorithm has to take the whole network into account. The restriction also provides the opportunity to form a compact binary format with an acceptable accuracy.

15

Rule – 2 *All lengths are integer values. If there are float values available then we will round these values to get an integer representation.*

20

Different maps might store the length values in different formats and also with different precision and the uniform basis for all is the usage of integer values. It is also more compact to transmit integer values in a binary format than using float values.

25

Rule – 3 *Two LRPs are mandatory and the number of intermediate LRPs is not limited.*

A line location reference must always have at least two location reference points indicating the start and the end of the location. If the encoder detects critical situations where the decoder (on a different map) might get into trouble, the location reference might be enhanced with additional intermediate LRPs.

30

Rule – 4 *The coordinates of the LRPs shall be chosen on real network nodes.*

These real network nodes shall be junctions in the real world and it is expected that these junctions can be found in different maps with a higher probability than positions somewhere on a line. Additionally nodes shall be avoided which can be easily skipped during a route search. At these avoidable nodes it is not possible to deviate from a route.

Nodes having only one incoming and one outgoing line shall be avoided since these nodes are not related to junctions (see Figure 19) and can be stepped over during route search. Nodes which have two incoming and two outgoing lines and there are only two adjacent nodes shall also be avoided (see Figure 20).

If one of these nodes is selected for a LRP then this LRP should be shifted along the location reference path in order to find a suitable node. This can be done since a route calculation will step over such avoidable nodes without leaving the desired path.

If the start or the end of a location is placed on avoidable nodes then the encoder should expand the location uniquely and should find a suitable node outside of the location. This expansion must never go into the location because this will shorten the location.

1.3.1. Overview of the data format rules

The following Table A5 summarizes the data format rules.

Rule	Description	Value
Rule 1	max distance between two consecutive LRPs	15000 m
Rule 2	road length values	treated as integer values
Rule 3	number of LRPs	at least two LRPs
Rule 4	avoidable nodes	LRPs shall be placed on real

		network nodes (also valid for start and end of a location)
--	--	--

Table A5: Data format rules overview

1.4 Binary representation

The physical data format describes a byte-oriented stream format for the logical data format specified above. It uses the components described in the logical data format in section 1.1.

1.4.1. Data types

The physical data format uses the following data types. Table A6 gives an overview of all available data types and specifies the name, the type and the designated size of each data type. In the following sections the data type names are used to indicate the size and type for each data component.

Data type name	Type	Size	Range
Boolean	flag with true=1, false=0	1 bit	0 – 1
uByte	unsigned integer	1 byte	0 – 255
uShort	unsigned integer	2 bytes	0 – 65535
uSmallInt	unsigned integer	3 bytes	0 – 16777215
uInteger	unsigned integer	4 bytes	0 – 4294967295
sByte	signed integer	1 byte	-128 – 127
sShort	signed integer	2 bytes	-32768 – 32767
sSmallInt	signed integer	3 bytes	-8388608 – 8388607

sInteger	signed integer	4 bytes	-2147483648 – 2147483647
String[n]	array of n characters	n bytes	variable size
BitField[n]	array of n bits	n bits	variable size

Table A6: Physical format: Data types

Negative integer values are stored in the two’s complement format.

5 **1.4.2. Coordinates (COORD)**

Each point in a map consists of a coordinate pair “longitude” (lon) and “latitude” (lat) represented in WGS84 coordinates. The directions north and east are represented by positive values (longitude and latitude respectively). The lon and lat values are stored in a decamicrodegrees resolution (10^{-5} , five decimals).

10

The coordinate values will be transmitted as integer values. These values will be generated using Equation E1 which calculates a 24-bit integer representation. The resolution parameter is set to 24. This translation leads to an error of about 2.4 meter at most. The backward translation is described in Equation E2. Both equations make use of the signum function which is -1 for negative values, 1 for positive values and 0 otherwise.

15

$$\text{int} = \left(\text{sgn}(\text{deg}) * 0.5 + \frac{\text{deg} * 2^{\text{Re solution}}}{360^\circ} \right)$$

Equation E1: Transformation from decimal coordinates into integer values

20

$$\text{deg} = \left(\frac{(\text{int} - \text{sgn}(\text{int}) * 0.5) * 360^\circ}{2^{\text{Re solution}}} \right)$$

Equation E2: Transformation from integer values into decimal coordinates

The physical format makes use of an absolute and a relative coordinate format. The absolute format represents the designated values of the geographical position and the relative value is the offset the coordinates relative to the preceding coordinate.

5 **1.4.2.1 Absolute format**

The absolute format describes geographical position in a 24-bit resolution. Table A7 shows the data type used for the absolute format.

Data type	Value	Description
sSmallInt	-8388608 – +8388607	24 bit representation

Table A7: Physical format: Coordinate format (absolute)

10

1.4.2.2 Relative format

The relative format is used to describe differences between two consecutive coordinates. The difference is calculated for each value (lon/lat) separately as shown in Equation E3. The current and previous values represent the latitude (longitude) value in degrees. The difference between these two values is multiplied with 100000 in order to resolve an integer value.

15

$$relative = round(100000 * (currentPoint - previousPoint))$$

Equation E3: Relative coordinates calculation

20

Table A8 shows the maximum distances which are possible using a 16-bit representation. The figures are calculated for a fixed coordinate at lon = 5° and lat = 52° (location in the Netherlands).

byte	latitude	longitude

	lower bound	upper bound	lower bound	upper bound
2	-36459 m	36460 m	-22504 m	22504 m

Table A8: Physical format: Longitude/Latitude ranges for relative coordinates

Table A9 shows the data type for 2 bytes offsets.

Data type	Value	Description
sShort	-32768 – +32767	2 bytes relative coordinates

5

Table A9: Physical format: Coordinate format (relative)

1.4.3. Attribute values

The binary format of the attributes will follow in this section.

10 **1.4.3.1 Functional Road Class (FRC)**

The functional road class (FRC) can hold eight different values as described in the logical format. These eight values are represented by 3 bits and the mapping is shown in Table A10.

Data type	Value (integer)	Value (binary)	Description
BitField[3]	0	000	FRC 0 – Main road
	1	001	FRC 1 – First class road
	2	010	FRC 2 – Second class road
	3	011	FRC 3 – Third class road

	4	100	FRC 4 – Fourth class road
	5	101	FRC 5 – Fifth class road
	6	110	FRC 6 – Sixth class road
	7	111	FRC 7 – Other class road

Table A10: Physical format: Functional road class

1.4.3.2 Form of way (FOW)

The form of way (FOW) can hold eight different values as described in the logical format.

- 5 These eight values are represented by 3 bits and the mapping is shown in TableA11.

Data type	Value (integer)	Value (binary)	Description
BitField[3]	0	000	UNDEFINED
	1	001	MOTORWAY
	2	010	MULTIPLE_CARRIAGEWAY
	3	011	SINGLE_CARRIAGEWAY
	4	100	ROUNABOUT
	5	101	TRAFFICSQUARE
	6	110	SLIPROAD
	7	111	OTHER

Table A11 Physical format: Form of way

1.4.3.3 Bearing (BEAR)

The bearing describes the angle between the road and the true North as described in the logical format. The physical data format defines 32 sectors whereby each sector covers 11.25° of the circle. These 32 sectors are represented by 5 bits. Table A12 shows the data type for the bearing attribute and Table A13 shows the mapping from the sectors to the concrete value.

5

Data type	Value	Description
BitField[5]	0-31	number of the sector in which the angle between the North and the line specified in the logical data format is located; the full circle is divided into 32 sectors each covering an angle of 11.25°.

Table A12: Physical format: Bearing

Value	Sector	Value	Sector
0	000.00° ≤ x < 011.25°	16	180.00° ≤ x < 191.25°
1	011.25° ≤ x < 022.50°	17	191.25° ≤ x < 202.50°
2	022.50° ≤ x < 033.75°	18	202.50° ≤ x < 213.75°
3	033.75° ≤ x < 045.00°	19	213.75° ≤ x < 225.00°
4	045.00° ≤ x < 056.25°	20	225.00° ≤ x < 236.25°
5	056.25° ≤ x < 067.50°	21	236.25° ≤ x < 247.50°

	067.50°		247.50°
6	067.50° ≤ x < 078.75°	22	247.50° ≤ x < 258.75°
7	078.75° ≤ x < 090.00°	23	258.75° ≤ x < 270.00°
8	090.00° ≤ x < 101.25°	24	270.00° ≤ x < 281.25°
9	101.25° ≤ x < 112.50°	25	281.25° ≤ x < 292.50°
10	112.50° ≤ x < 123.75°	26	292.50° ≤ x < 303.75°
11	123.75° ≤ x < 135.00°	27	303.75° ≤ x < 315.00°
12	135.00° ≤ x < 146.25°	28	315.00° ≤ x < 326.25°
13	146.25° ≤ x < 157.50°	29	326.25° ≤ x < 337.50°
14	157.50° ≤ x < 168.75°	30	337.50° ≤ x < 348.75°
15	168.75° ≤ x < 180.00°	31	348.75° ≤ x < 360.00°

Table A13: Physical format: Bearing value definition

Equation E4 outlines the calculation of the bearing value and Figure 21 provides a graphical overview of the sectors.

$$value = \left\lfloor \frac{angle}{11.25^\circ} \right\rfloor, 0^\circ \leq angle < 360^\circ$$

Equation E4: Calculation of the bearing value

1.4.3.4 Distance to next LRP (DNP)

5 The DNP attribute measures the distance between two consecutive LRPs along the location reference path as described in the logical format.

The physical data format defines an 8-bit representation and Table A14 shows the data type used for DNP. This representation defines 255 intervals and in combination with rule

10 1 of the data format rules (maximum length between two consecutive LRPs is limited by 15000m) each interval will have a length of 58.6 meters.

Data type	Value	Description
BitField[5]	0-255	distance interval according to Equation E5

Table A14: Physical format: Distance to next point

15 Equation E5 shows how the DNP values can be calculated.

$$value = \left\lfloor \frac{length}{58.6m} \right\rfloor$$

Equation E5: Calculation of the DNP value

20 **1.4.3.5 Lowest FRC to next point (LFR CNP)**

The lowest FRC to the next point indicates the lowest functional road class used in the location reference path to the next LRP. This information could be used to limit the

number of road classes which need to be scanned during the decoding. See Table A15 for a definition of the data type.

Data type	Value	Description
BitField[3]	0-7	holds the same values as described in Table A10

Table A15: Physical format: Lowest FRC to next point

5

1.4.4. Location Reference header

The Location Reference header contains general information about the reference.

1.4.4.1 Version (VER)

10 The version is used to distinguish between several physical and data formats for location references. The version number is represented by 3 bits and the data type is shown in Table A16.

Data type	Value	Description
BitField[3]	0-7	current version number

Table A16: Physical format: Version

15

1.4.4.2 Attribute flag (AF)

The attribute flag indicates whether there are attributes appended to each LRP or not. The AF value is 0 if no attributes are appended and therefore the location reference only consists of coordinates. Otherwise a value of 1 indicates that attributes are appended to each LRP. The data type for the AF is shown in Tables A17 and A18.

20

Data	Value	Description
------	-------	-------------

type		
Boolean	0, 1	flag, indicating whether attributes are appended to each LRP or not

Table A17: Physical format: Attribute flag

Value	Description
0	no attributes are appended
1	for each LRP a set of attributes is appended

Table A18: Physical format: Attribute flag values

5

1.4.4.3 Area flag (ArF)

The area flag indicates whether the location reference describes an area or not. If this flag is set then the location shall be connected and we describe an area, as seen in Tables A19 and A20 below.

10

Data type	Value	Description
Boolean	0, 1	flag, indicating whether the location reference describes an area or not

Table A19: Physical format: Area flag

Value	Description
0	location reference describes no area

1	location reference describes an area
---	--------------------------------------

Table A20: Physical format: Area flag values

1.4.5. Offsets

Offsets are used to locate the start and end of a location more precise than bound to the nodes in a network. The logical format defines two offsets, one at the start of the location and one at the end of the location and both offsets operate along the lines of the location and are measured in meters. The offset values are not mandatory and a missing offset value means an offset of 0 meters. Offsets are also only valid for line locations which have attributes included.

10

1.4.5.1 Offset flags

Offset flags indicate whether the data includes a specific offset information or not. The physical data format deals with two flags corresponding to the two different offset values. The positive offset flag (PoffF) and the negative offset flag (NoffF) are described in Tables A21 and A22.

15

Data type	Value	Description
Boolean	0, 1	flag, indicating whether the corresponding offset value is included in the data or not

Table A21: Physical format: Offset flag

Value	Description
0	location reference data does NOT include the corresponding offset information

1	location reference data includes the corresponding offset information
---	---

Table A22: Physical format: Offset flag values

1.4.5.2 Offset values

The offset values (positive and negative, POFF and NOFF) indicate the distance between the start (end) of the location reference path and the “real” start (end) of the location.

The physical data format defines an 8-bit representation for each offset value. Table A23 shows the data type used for POFF and NOFF. This representation allows us to define 256 intervals with a length of each interval of 58.6 meters. The interval number calculation for offsets is outlined in Equation E6.

Data type	Value	Description
BitField[5]	0-255	offset length interval according to Equation E6

Table A23: Physical format: Offset

$$value = \left\lfloor \frac{offset\ length}{58.6m} \right\rfloor$$

Equation E6: Calculation of offset values

1.5 Physical data format specification

This section describes the arrangement of the data fields in a byte stream. It is assumed that we have a byte-oriented stream and we can use 8 bits per byte.

1.5.1. Overview

The main structure of the binary format is:

Header, First LRP, following LRPs, Last LRP, and offsets

5

The Header, the first LRP and the last LRP are mandatory and the number of following LRPs is not limited. The Last LRP has its own structure due to a different information level.

Offsets are optional and the existence will be indicated by flags in the attributes of the last LRP.

10

Table A24 gives an overview of the main structure. The stream can be read from the left to the right, so that the first received byte will be the status byte. For each coordinate the first received value will be the longitude value followed by the latitude value.

15 The calculation of message sizes depending on the number of LRPs can be found in section 1.6 below.

Structure	Header	First LRP					following LRP					...
Name	Status	absolute Longitude	absolute Latitude	attr. 1	attr. 2	attr. 3	relative Longitude	relative Latitude	attr. 1	attr. 2	attr. 3	...
# bytes	1	3	3	1	1	1	2	2	1	1	1	...
description	section 1.5.2	Section 1.5.3	section 1.5.3	section 1.5.5 .1	section 1.5.5 .2	section 1.5.5 .3	section 1.5.4	section 1.5.4	section 1.5.5 .1	section 1.5.5 .2	section 1.5.5 .3	...

Structure	...	last LRP				positive offset	negative offset
Name	...	relative Longitude	relative Latitude	attr. 1	attr. 4	offset	offset
# bytes	...	2	2	1	1	1	1
description	...	section 1.5.3	section 1.5.3	section 1.5.5.1	section 1.5.5.4	section 1.5.6	section 1.5.6

Table A24: Binary format overview

1.5.2. Status byte

5 The status byte is transmitted once for every location reference and contains the area flag (ArF, section 1.4.4.3), attribute flag (AF, section 1.4.4.2) and the version information (VER, section 1.4.4.1). The bits 7, 6 and 5 are reserved for future use (RFU) and shall be 0. Table A25 gives an overview of the usage of each bit in the status byte.

Bit	7	6	5	4	3	2	1	0
used for	RFU	RFU	RFU	Arf	AF	VER		

Table A25: Status byte

In this particular version of the format, attributes are added to each LRP and areas are not described. If the “current version” is 2, the status byte will have the value shown in Table A26:

Bit	7	6	5	4	3	2	1	0
value	0	0	0	0	1	010		

5

Table A26: Status byte value

1.5.3. First LRP coordinates

The coordinates of the first LRP are transmitted in an absolute format (see section 1.4.2.1) and therefore each value (lon and lat) will use 3 bytes. Table A27 shows the byte order for longitude and latitude values.

10

Bit	2	2	2	2	1	1	1	1	1	1	1	1	1	1	9	8	7	6	5	4	3	2	1	0
used for	highest byte								middle byte								lowest byte							

Table A27: First LRP coordinates

1.5.4. Following LRP coordinates

The coordinates of the following LRPs and the last LRP are transmitted in a relative format (see section 1.4.2.2) and therefore each value (lon and lat) will use 2 bytes. Table A28 shows the byte order for longitude and latitude values.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
used	highest byte								lowest byte							

for		
-----	--	--

Table A28: Following LRPs coordinates

1.5.5. Attributes

Attributes are added to each LRP. There are 4 different types of attributes depending on the position of a LRP in the location reference.

1.5.5.1 First attribute byte (attr. 1)

The first attribute byte contains the attributes FRC (see section 1.4.3.1) and FOW (see section 1.4.3.2) and two bits are reserved for future use. Table A29 shows the usage of each bit.

Bit	7	6	5	4	3	2	1	0
used for	RFU	RFU	FRC		FOW			

Table A29: First attribute byte – valid for all LRPs

1.5.5.2 Second attribute byte (attr. 2)

The second attribute byte contains the attributes LFRCNP (see section 1.4.3.5) and BEAR (see section 1.4.3.3). Table A30 shows the usage of each bit. This attribute is not valid for the last LRP since there is no LFRCNP information available.

Bit	7	6	5	4	3	2	1	0
used for	LFRCNP			BEAR				

Table A30: Second attribute byte – valid for all LRPs, except the last LRP

1.5.5.3 Third attributes byte (attr. 3)

The third attribute byte contains the attribute DNP (see section 1.4.3.4) as shown in Table A31. This attribute is not valid for the last LRP since there is no DNP information available.

Bit	7	6	5	4	3	2	1	0
used for	DNP							

5 **Table A31: Third attribute byte – valid for all LRPs, except the last LRP**

1.5.5.4 Fourth attribute byte (attr. 4)

The attribute 4 contains the BEAR information, the positive and negative offset flags (see section 1.4.5.1) and one bit is reserved for future use. This attribute is used for the last LRP, as shown in Table A32.

10

Bit	7	6	5	4	3	2	1	0
used for	RFU	POFF	NOFF	BEAR				

Table A32: Fourth attribute bytes – valid only for the last LRP

1.5.6. Offset

15 The positive offset (POFF) and negative offset (NOFF) are only included if the corresponding flags in attribute 4 indicate their existence. Absent offset values indicate an offset of 0 meters. The offset values are calculated according to section 1.4.5., and bit usage for these offsets is shown in Tables A33, A34.

Bit	7	6	5	4	3	2	1	0
-----	---	---	---	---	---	---	---	---

used for	POFF
-------------	------

Table A33: Positive offset value

Bit	7	6	5	4	3	2	1	0
used for	NOFF							

Table A34: Negative offset value

5 **1.6 Message size calculation**

The message size of a location reference depends on the number of LRPs included in the location reference. There must be at least two LRPs in the location reference. Also mandatory is the header with the status information. The following calculation and Table A35 show message sizes depending on the number of LRPs.

10

- *Header*
1 byte status
Total: 1 byte

15

- *First LRP*
6 bytes COORD (3 bytes each for lon / lat)
3 bytes Attributes
Total: 9 bytes

20

- *Following LRPs*
4 bytes COORD (2 bytes each for lon / lat)
3 bytes Attributes
Total: 7 bytes

- *Last LRP*
 4 bytes COORD (2 bytes each for lon / lat)
 2 bytes Attributes
 Total: 6 bytes

5

- *Offset (if included)*
 1 byte positive offset (if included)
 1 byte negative offset (if included)
 Total: 0 – 2 bytes

10

# LRPs	Message size
2	16 bytes (+1 or +2 bytes offset, if included)
3	23 bytes (+1 or +2 bytes offset, if included)
4	30 bytes (+1 or +2 bytes offset, if included)
5	37 bytes (+1 or +2 bytes offset, if included)
6	44 bytes (+1 or +2 bytes offset, if included)
7	51 bytes (+1 or +2 bytes offset, if included)

8	58 bytes (+1 or +2 bytes offset, if included)
...	...
$n (n > 1)$	$1 + 9 + (n-2) * 7 + 6$ bytes (+1 or +2 bytes offset, if included)

Table A35: Message sizes depending on the number of LRPs

A specific example of the manner in which the above formats are used is now provided with reference to the location reference described above with reference to Figures 9, 10, 11 and 12 in which three location reference points (nodes ①, ⑩ and ⑮) and lines ①-③, ⑩-⑪ and ⑭-⑮) are identified as precisely describing a location.

The location reference consists of three location reference points and Table A36 below shows the coordinates for the nodes ①, ⑩ and ⑮. These nodes are the corresponding nodes to the location reference points. In preparation of the binary format this table also shows the relative coordinates. The node ① corresponds to the location reference point 1 and will have coordinates in absolute format. Node ⑩ corresponding to location reference point 2 will have relative coordinates to the location reference point 1. Node ⑮ corresponding to location reference point 2 will also have relative coordinates but now referencing to location reference point 2.

15

Node ID	LRP index	Longitude	Latitude	Relative longitude	Relative latitude
①	1	6.12683°	49.60851°	--	--
⑩	2	6.12838°	49.60398°	155	-453
⑮	3	6.12817°	49.60305°	-21	-93

Table A36: Example coordinates

The relative longitude and latitude are calculated according Equation E3 above. The offsets being calculated in step 2 of the encoding process are shown in Table A37. In the binary

data only the positive offset will appear because the negative offset is 0 and a missing offset will be treated as 0.

Field	Value
positive Offset	150
negative Offset	0

Table A37: Example offset values

5

Table A38 below collects the relevant data for each location reference point from the underlying digital map, and through calculation. This includes the functional road class, the form of way and the bearing of the corresponding line. The needed information about the path between two subsequent location reference points is also shown (lowest functional road class and distance to the next location reference point).

10

LRP index	FRC	FOW	BEAR	LFRCNP	DNP
1	FRC3	MULTIPLE_CARRIAGEWAY	135°	FRC3	561
2	FRC3	SINGLE_CARRIAGEWAY	227°	FRC5	274
3	FRC5	SINGLE_CARRIAGEWAY	290°	--	--

Table A38: Location reference points determined during encoding

The BEAR, LFRCNP and DNP attributes are determined as described above:

15

The following tables above hold all relevant information for creating the binary data. The following tables outline the binary data according to the Physical Data Format:

- Status byte: see Table A39
- LRP 1: see Table A40 to Table A44
- LRP 2 see Table A45 to Table A49
- LRP 3 see Table A50 to Table A53
- Offset see Table A54

20

Bit	7	6	5	4	3	2	1	0
-----	---	---	---	---	---	---	---	---

Description	RFU	RFU	RFU	ArF	AF	Version		
Value	0	0	0	0	1	0	1	0

Table A39: Binary example: status byte

Byte	First								Second								Third							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Value	0	0	0	0	0	1	0	0	0	1	0	1	1	0	1	1	0	1	0	1	1	0	1	1

Table A40: Binary example: LRP 1 – absolute longitude

5

Byte	First								Second								Third							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Value	0	0	1	0	0	0	1	1	0	1	0	0	0	1	1	0	1	1	1	1	0	1	0	0

Table A41: Binary example: LRP1 – absolute latitude

Bit	7	6	5	4	3	2	1	0
Description	RFU	RFU	FRC				FOW	
Value	0	0	0	1	1	0	1	0

Table A42: Binary example: LRP1 – attribute 1

Bit	7	6	5	4	3	2	1	0
Description	LFRCNP				Bearing			
Value	0	1	1	0	1	1	0	0

10

Table A43: Binary example: LRP1 – attribute 2

Bit	7	6	5	4	3	2	1	0
Description	DNP							
Value	0	0	0	0	1	0	0	1

Table A44: Binary example: LRP1 – attribute 3

Byte	First								Second							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Value	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1

Table A45: Binary example: LRP2 – relative longitude

Byte	First								Second							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Value	1	1	1	1	1	1	1	0	0	0	1	1	1	0	1	1

Table A46: Binary example: LRP2 – relative latitude

Bit	7	6	5	4	3	2	1	0
Description	RFU	RFU	FRC			FOW		
Value	0	0	0	1	1	0	1	1

5

Table A47: Binary example: LRP2 – attribute 1

Bit	7	6	5	4	3	2	1	0
Description	LFRCNP				Bearing			
Value	1	0	1	1	0	1	0	0

Table A48: Binary example: LRP2 – attribute 2

Bit	7	6	5	4	3	2	1	0
Description	DNP							
Value	0	0	0	0	0	1	0	0

Table A49: Binary example: LRP2 – attribute 3

10

Byte	First								Second							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Value	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1

Table A50: Binary example: LRP3 – relative longitude

Byte	First								Second							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Value	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1	1

Table A51: Binary example: LRP3 – relative latitude

Bit	7	6	5	4	3	2	1	0
Description	RFU	RFU	FRC			FOW		
Value	0	0	1	0	1	0	1	1

Table A52: Binary example: LRP3 – attribute 1

Bit	7	6	5	4	3	2	1	0
Description	RFU	PoffF	NoffF	Bearing				
Value	0	1	0	1	1	0	0	1

5

Table A53: Binary example: LRP3 – attribute 4

Bit	7	6	5	4	3	2	1	0
Description	POFF							
Value	0	0	0	0	0	0	1	0

Table A54: Binary example: positive Offset

10 The full binary data stream will have a length of 24 bytes and consists of the following (ordered as bytes from left to right and top to down):

```

00001010    00000100    01011011    01011011    00100011    01000110
11110100    00011010    01101100    00001001    00000000    10011011
11111110    00111011    00011011    10110100    00000100    11111111
15 11101011    11111111    10100011    00101011    01011001    00000010
    
```

CLAIMS

1. A method of encoding a continuous path within a road network, said path being
5 completely represented within a digital map and expressible as a path list of lines and/or
segments existing in said digital map and consecutively ordered, said method comprising
the steps of:
- (i) storing a start position in a route search list, said start position being one of:
- the line or segment first appearing in said path list or, where the start node of said first
10 line or segment is artificial, the first line or segment appearing in said digital map having a
real start node and which leads directly to said first line or segment optionally through
other artificial nodes,
 - a most recently identified deviation line or segment also appearing in said path list,
- (ii) determining a path from the start node of the start position and including said start
15 position to an end node of the last line or segment in the path list within said digital map,
said path being determined according to an algorithm,
- (iii) comparing the shortest path so determined to the path list for identity, and in the
absence of identity, identifying at least one deviation line or segment being part of the
20 path list and having a start node representative of an intersection in said digital map but
not being the line or segment first appearing in said path list, and if such deviation line or
segment does not terminate at the end node of the last line or segment appearing in the
path list, repeating step (i) using said deviation line or segment, and
- (iv) Storing the last line or segment in the path list in said route search list if not already
stored.
- 25 2. A method according to claim 1 wherein the algorithm used in determination of the
path is a shortest path algorithm.
3. A method according to claim 1 wherein in step (iii), if the deviation line or segment
terminates at the end node of the last line or segment appearing in the path list, and the
30 predecessor of the last line or segment in the shortest path does not coincide with the
penultimate line or segment appearing in said path list, then a second deviation line or

segment is exceptionally identified being that line or segment emanating from the last node appearing in the path list which coincides with an intersection.

4. A method according to any preceding claim includes a step of converting the
5 resulting route search list into a machine-readable format represented in binary or a mark-up language such as XML.

5. A method according to any preceding claim including at least one of the following
10 further steps: concatenation, conversion, transposition, and validity checking, which result in a valid, ordered list of location reference points, or a machine-readable representation thereof.

6. A method according to any preceding claim wherein the method includes a
15 preliminary step of analysing each item in the path list representing said continuous path for validity, and in the event that the path list is not valid in a relevant respect, raising an exception.

7. A method according to either claim 5 or claim 6 wherein the validity check includes
20 a check to establish whether either or both of the start node of the first mentioned line or segment in the path list and the end node of the last mentioned in said path list coincide with a real node in the digital map and in the absence of such coincidence, the preliminary validity check includes identifying suitable real nodes and extending the continuous path accordingly by including additional lines or segments in the path list, and storing an offset representative of the distance between the real nodes and artificial nodes.

25

8. A method according to any preceding claims further including a step of imposing a
restriction on the maximum distance between successive location reference points.

9. A method according to claim 8 wherein the maximum distance so imposed is 15km.

30

10. A method according to any preceding claim including the further step, in the encoder, of determining whether a turn restriction check option is enabled, and if so enabled, assessing the location desired to be encoded for turn restrictions identified in the digital map and which may prejudice or compromise said location or make it impossible to navigate, and if such are identified, returning an error.
- 5
11. A computer program element comprising computer program code means to make a computer execute the method as set in any of claims 1-10.
- 10 12. A computer program as described in claim 11 embodied on a computer readable medium.
13. A system for encoding a continuous path location comprising an encoder operating as described in any of method claims 1-10, a database for storing pre-encoded locations and the results of previous attempts at encoding those locations, characterised in that the system, on receiving a location to be encoded, first queries the database to establish whether that location or a part of it, forms a part of or is identical to a location having been previously stored within said database, said system returning either the previously encoded location or a part of it in the case of encoding having already been effected, or alternatively passing the continuous path location to the encoder, the output of which is in any event stored in said database together with that continuous path location.
- 15
- 20

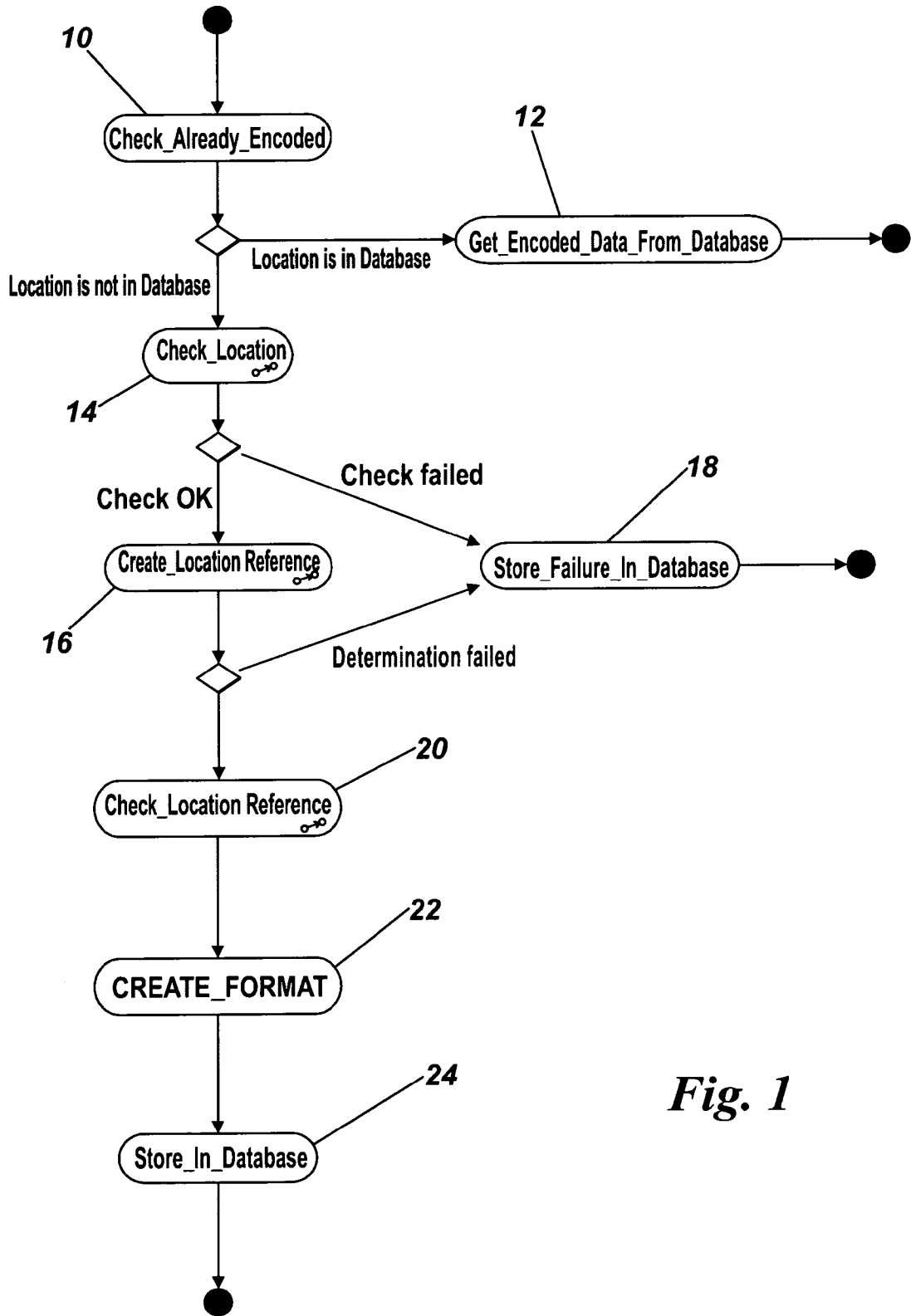


Fig. 1

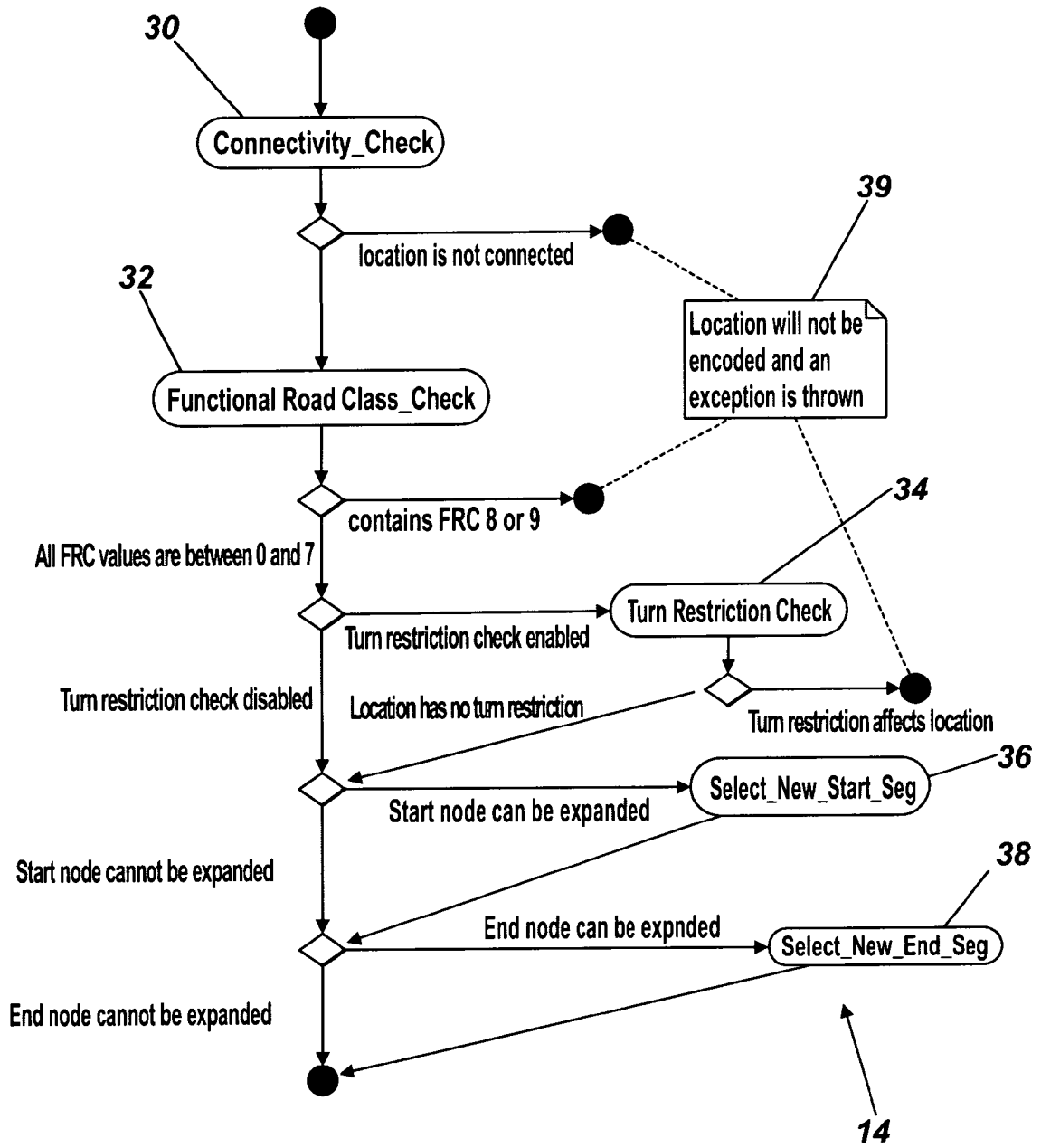


Fig. 2

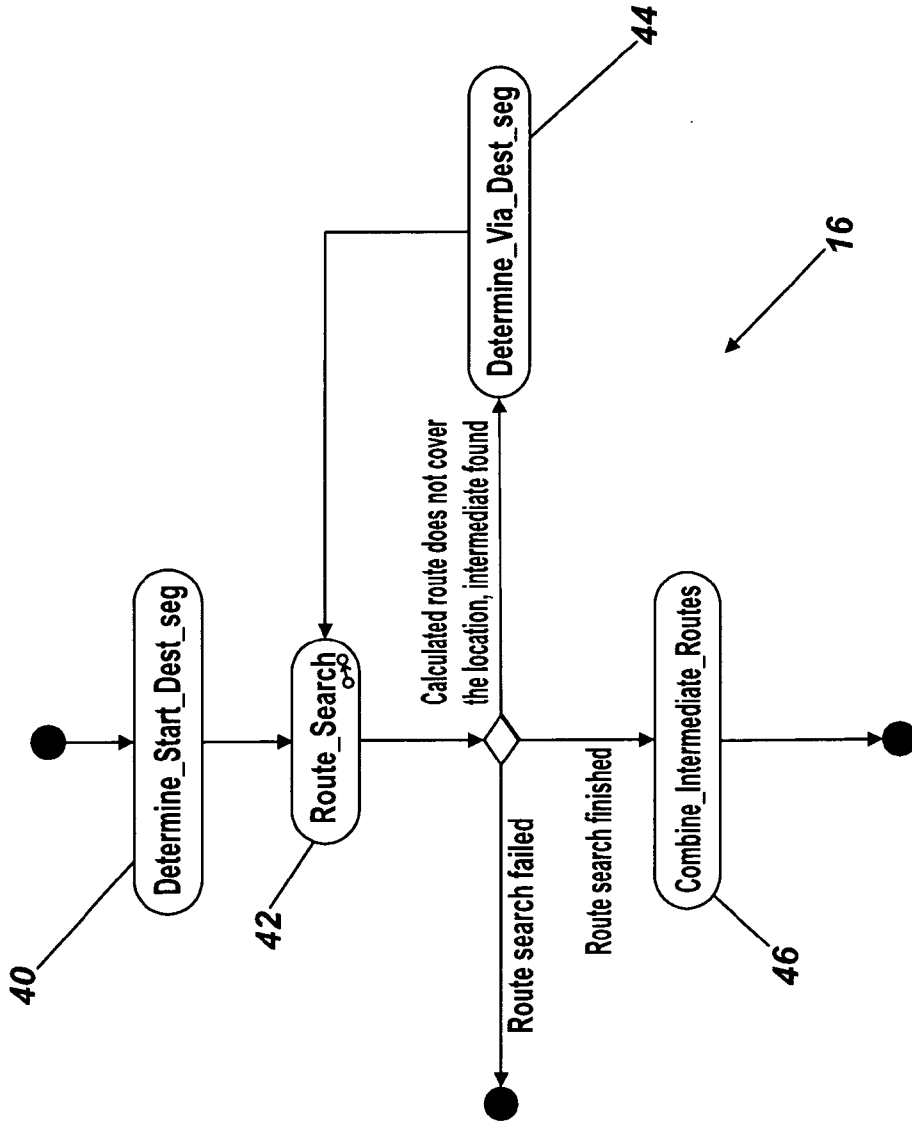


Fig. 3

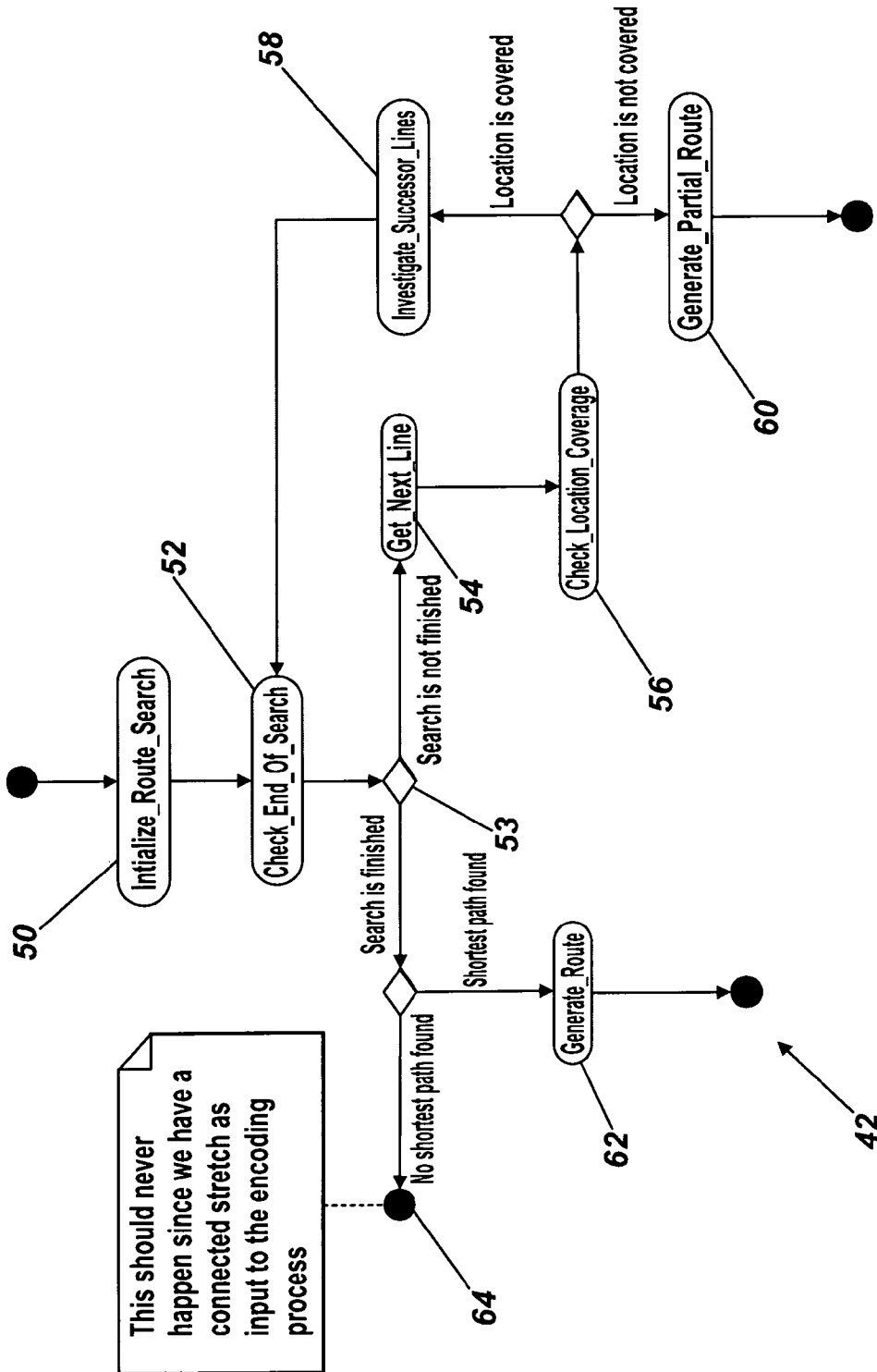


Fig. 4

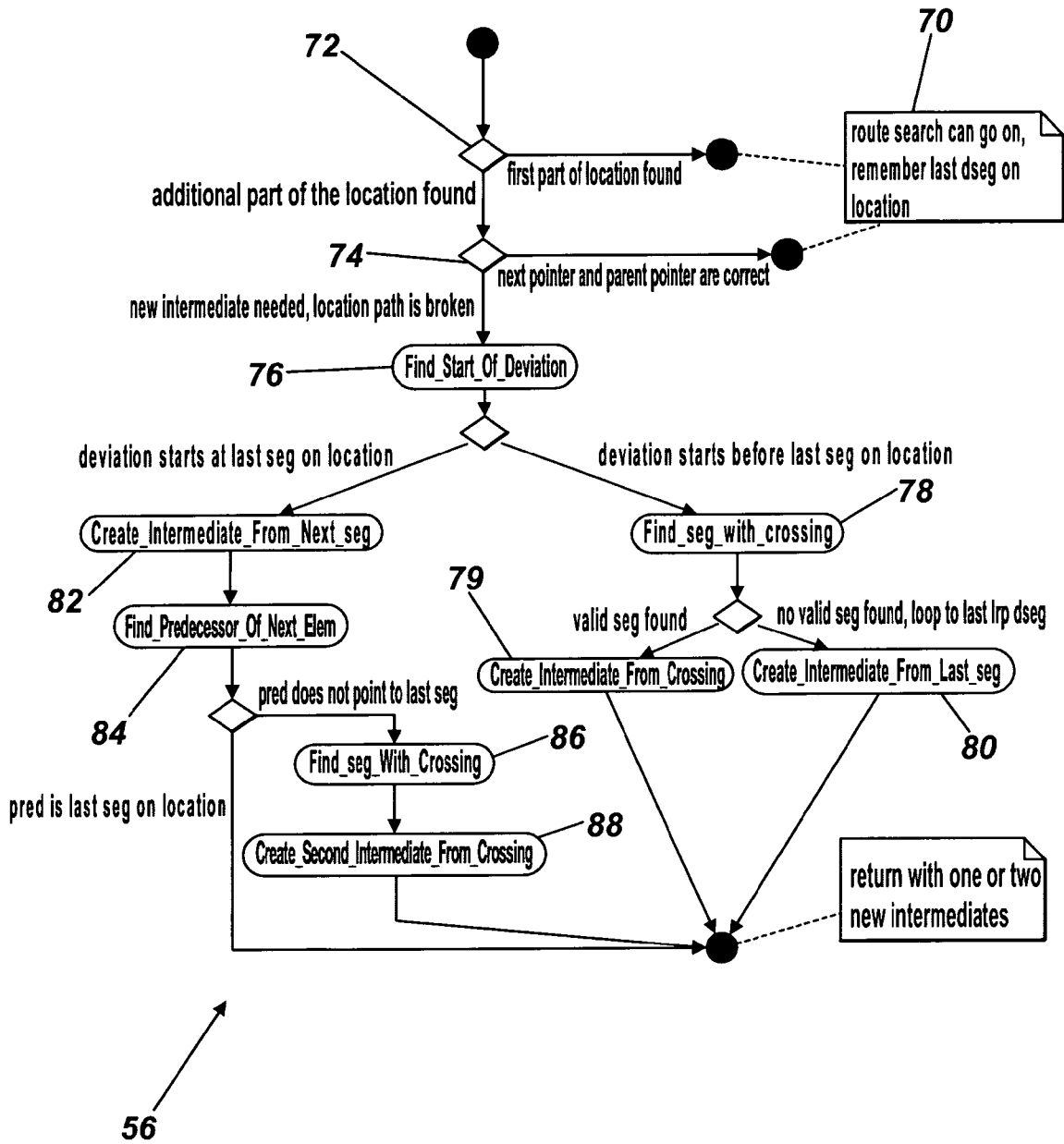


Fig. 5

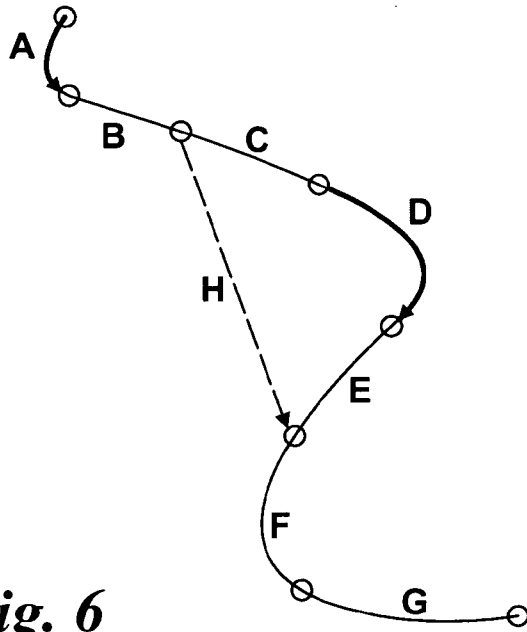


Fig. 6

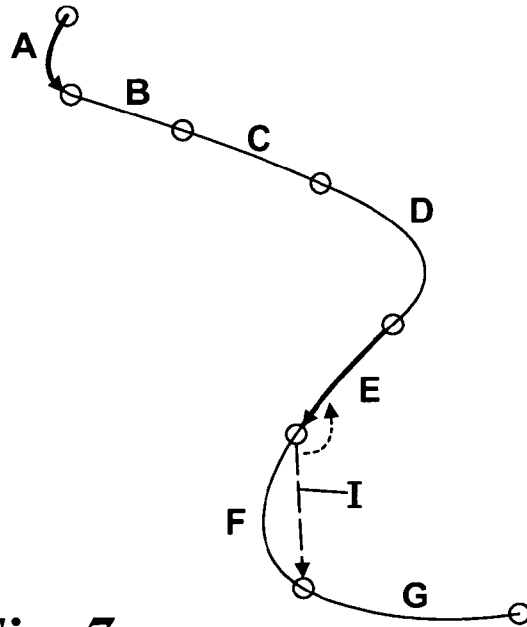


Fig. 7

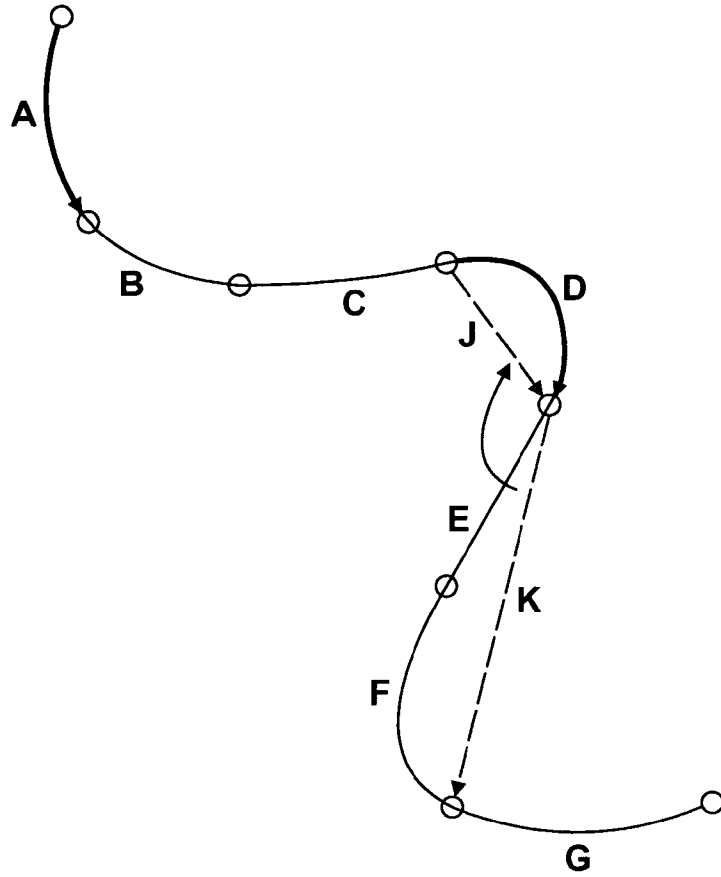


Fig. 8

8/14

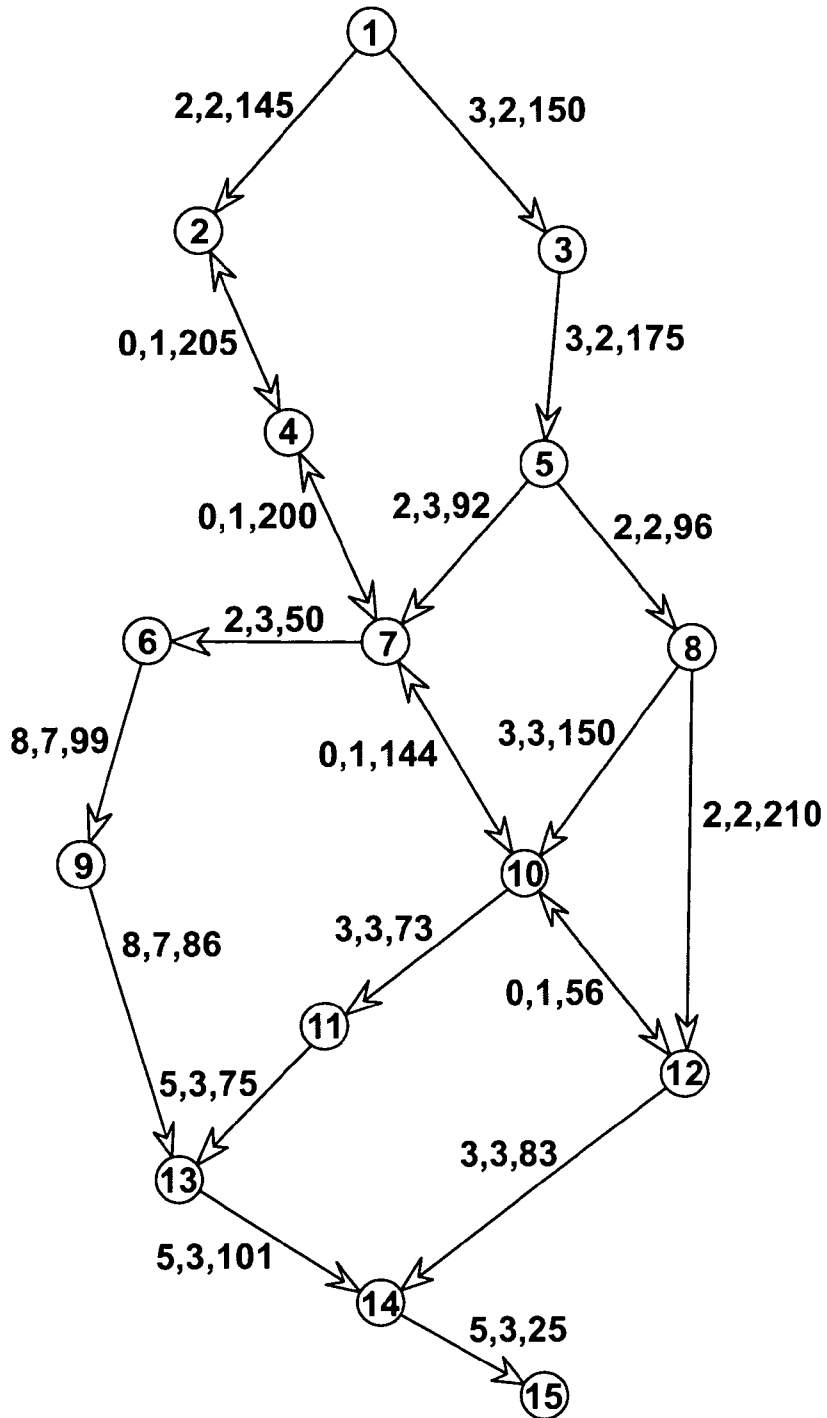


Fig. 9

9/14

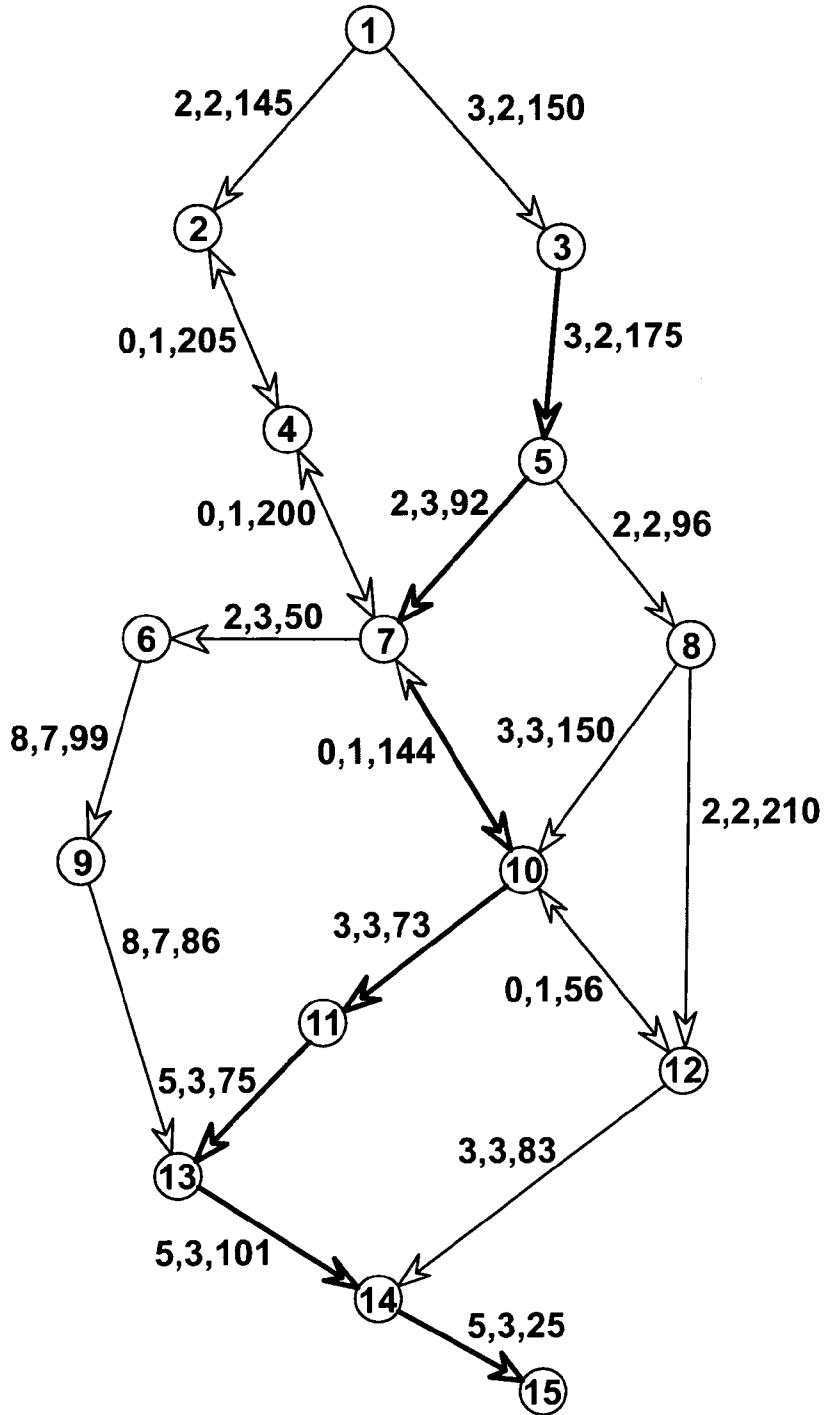


Fig. 10

10/14

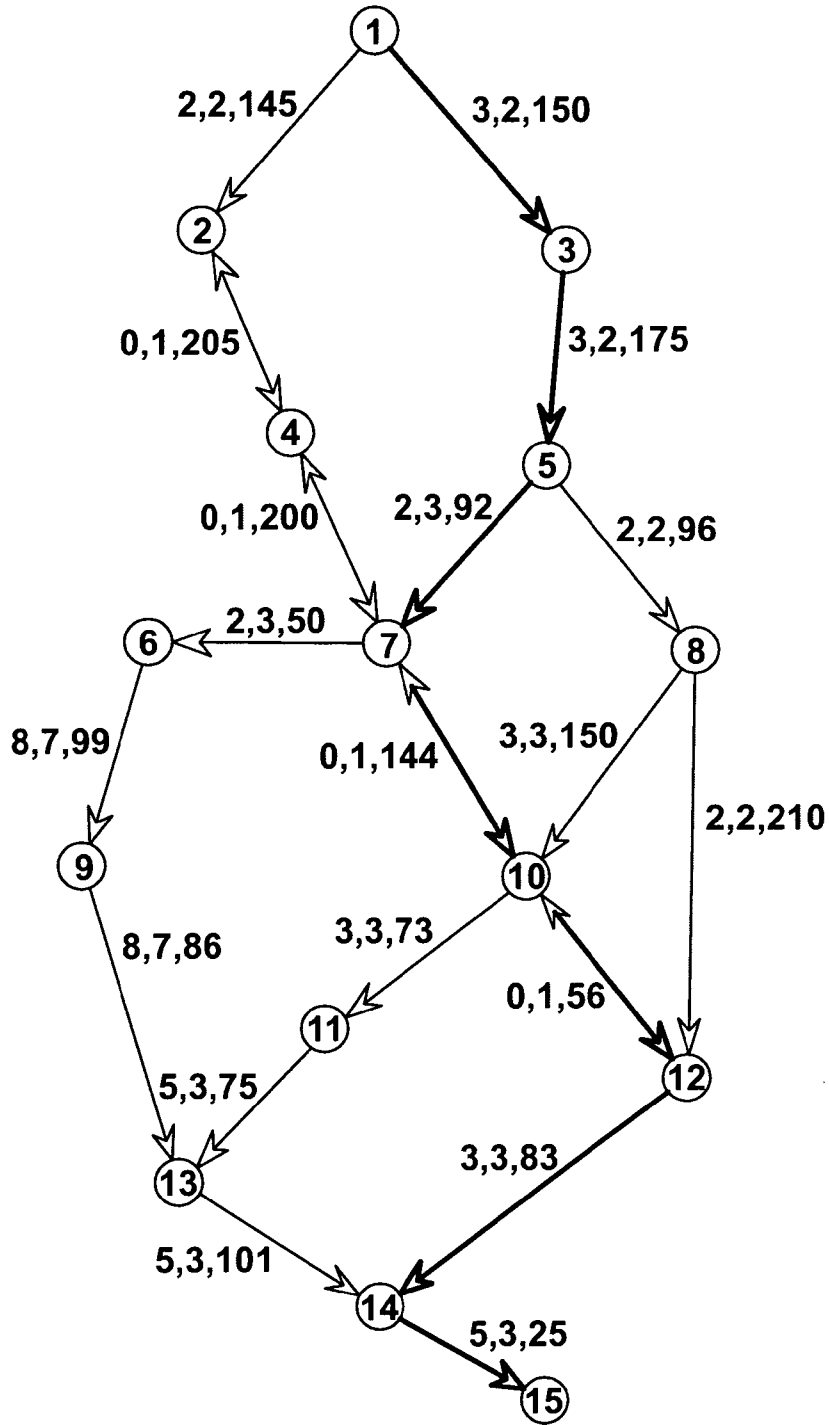


Fig. 11

11/14

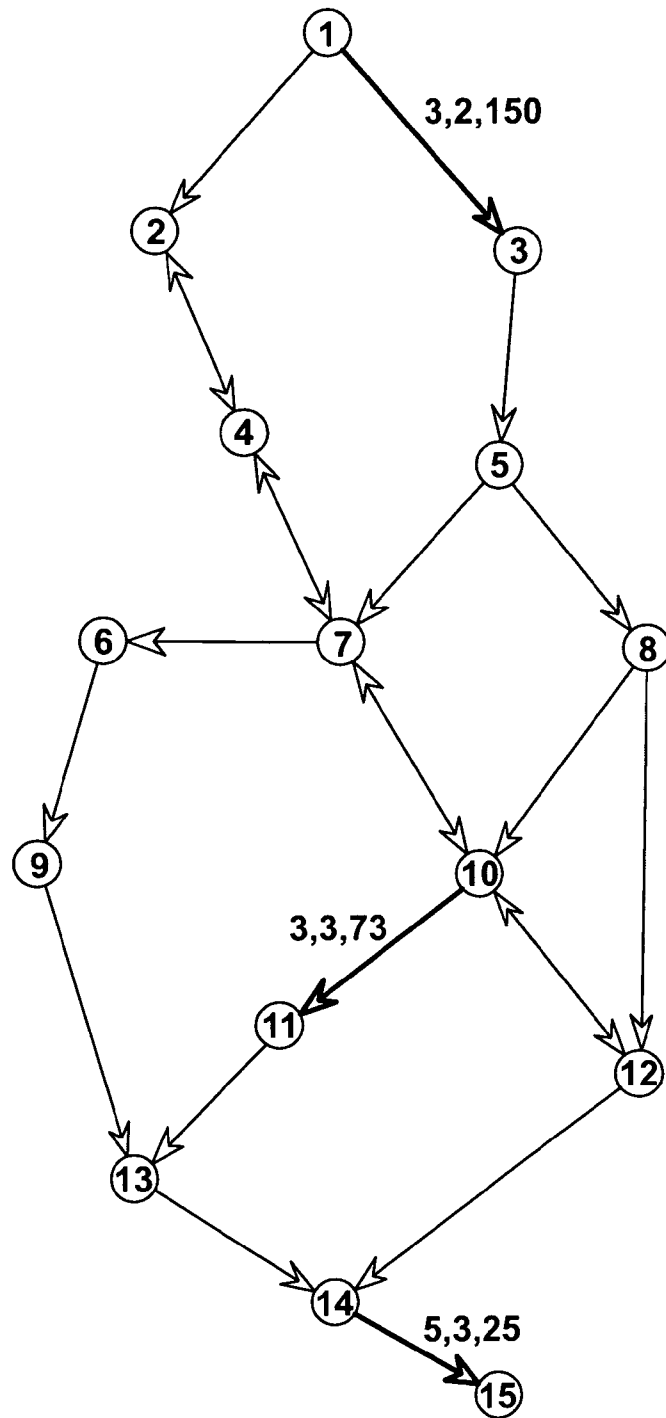
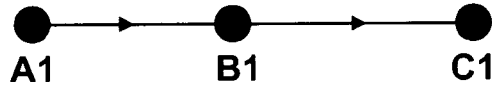


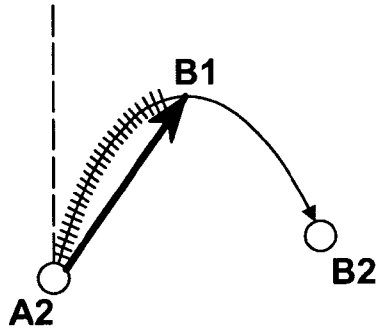
Fig. 12

12/14



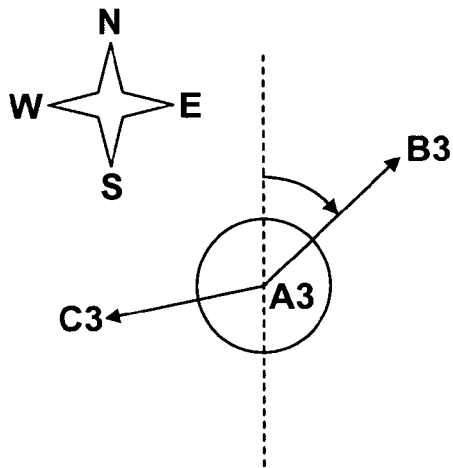
Connection of LRPs

Fig. 13



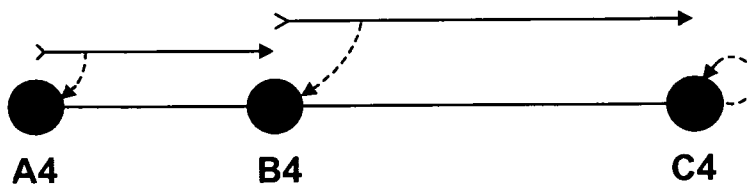
Logical format: Bearing point

Fig. 14



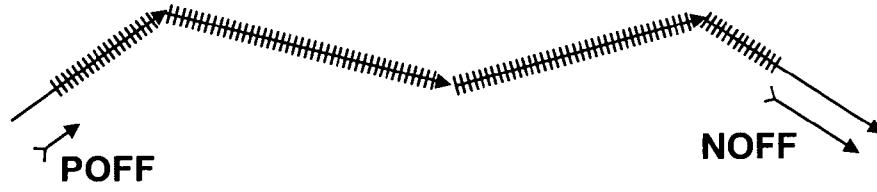
Logical format: Bearing

Fig. 15



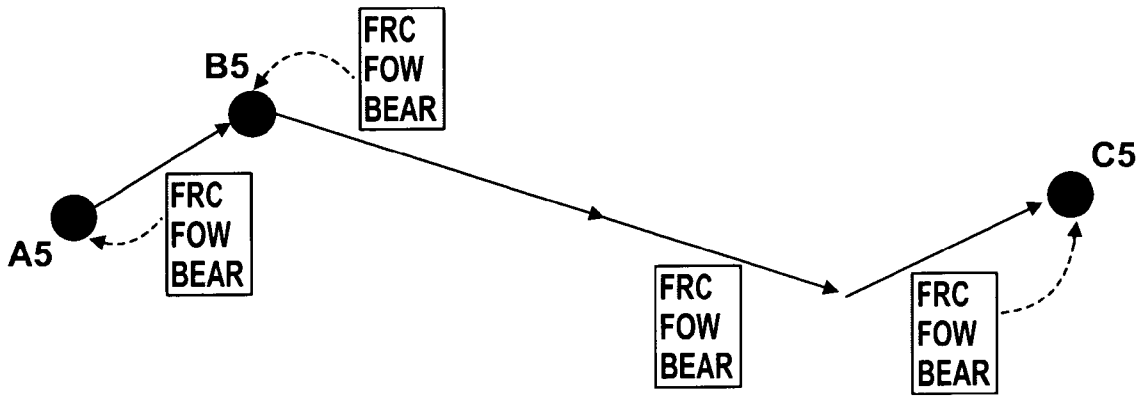
Logical format: Distance to next point

Fig. 16



Logical format: Positive and negative offset

Fig. 17



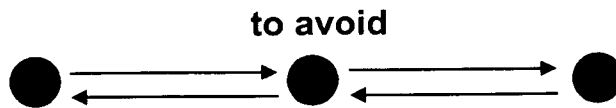
Relationship: Attributes - LRP

Fig. 18



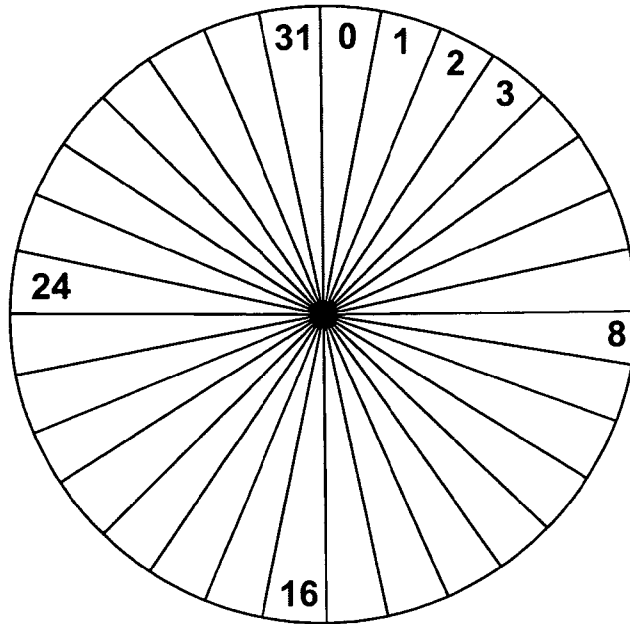
Avoid nodes (1)

Fig. 19



Avoid nodes (2)

Fig. 20



Physical format: Bearing sectors

Fig. 21

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/058131

A. CLASSIFICATION OF SUBJECT MATTER
 INV. G08G1/09 G01C21/00 G09B29/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
 Minimum documentation searched (classification system followed by classification symbols)
 G08G G01C G09B H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
 EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/223373 A1 (NAKAMURA YOSHIHIKO [JP] ET AL) 4 December 2003 (2003-12-04) the whole document	1-3, 11-13
X	GB 2 443 472 A (COTARES LTD [GB]) 7 May 2008 (2008-05-07)	1-3,5-11
A	page 1, line 1 - page 5, line 16; claims 1-31; figures 1-7 page 9, line 19 - page 46, line 11; claims 1-34	4
X	US 2004/039520 A1 (KHAVAKH ASTA [US] ET AL) 26 February 2004 (2004-02-26)	1-3,5-11
A	paragraph [0028] - paragraph [0210]; claims 1-30; figures 1-21	4
	-/--	

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
E earlier document but published on or after the international filing date	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
O document referring to an oral disclosure, use, exhibition or other means	*Z* document member of the same patent family
P document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 2 September 2009	Date of mailing of the international search report 10/09/2009
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Durucan, Emrullah
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/058131

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	the whole document -----	
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A	US 2006/122846 A1 (BURR JONATHAN [GB] ET AL) 8 June 2006 (2006-06-08) the whole document -----	1-3,5-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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