

Telecommunications method, processing modules and associated computer programmes

The present invention relates to a telecommunications method, from a transmitting station for data defining a value of at least one first parameter with a variable value V, intended for a receiving station.

For example, when intervention teams are each provided with a radio communications station, radio transmission of the geographical position of an intervention team to at least other intervention team is a major need within an intervention area of military forces.

It is desirable to reduce the volume of data required for transmitting the current geographical position. One solution is to reduce the accuracy of the position, from within 1 metre (m) for example to within 6 metres.

This reduction does not always prove to be sufficient and an encoding of the geographical position may then be performed relatively to a reference position. However, in such a case, the communications stations all have to be aware of this reference position for coding/reconstructing a geographical position, which is a penalty.

Indeed, if the reference position is set, it is necessary to define and to store in stations, the value of the reference position and to define a maximum operational position between a station and the reference position. Further, a station may not send its position if it is too far from the reference position since it risks sending a position which will be erroneous once it is decoded by the receivers. Therefore a significant margin is often provided in terms of maximum distance and of number of allocated bits, which reduces the benefit of this coding relative to a set reference position.

If the value of the reference position is updated dynamically, the telecommunications method is burdened by the requirement of transmitting at each update, this updated value to the stations. Further, in the station an identifying function and handling of the case of absence of the current reference position has to be implemented.

None of these solutions is therefore satisfactory, notably in the case of convoys of vehicles provided with radio communications stations, moving over a large distance, while remaining within radio range from each other.

The example above deals with radio transmission and with parameters indicating the geographical position of the transmitting station. More generally, it is always useful in any telecommunications method, either by wire or by radio, to reduce the volume of data to be transmitted in order to define a value of a variable parameter of the geographical localisation type or other type.

For this purpose, according to a first aspect, the invention proposes a telecommunications method of the aforementioned type, characterised in that said method comprises the following steps, the value V being such as it is located in the range $[V_R - V_{min}; V_R + V_{max}]$, with V_{min} and V_{max} being set and V_R being a current value of a second variable parameter determined by the receiving station upon receiving the data:

- determining by the transmitting station, the current value of said first parameter;
- calculating, by the transmitting station, the result of said determined variable value modulo N , wherein N is a function of $V_{min} + V_{max}$;

- transmitting by the transmitting station, data indicating the result of said variable value modulo N ;

- receiving, by the receiving station, said data;

- determining, by the receiving station, the current value of the second variable parameter, upon said reception by the receiving station;

- determining the integer part, called a $zone_R$ hereafter, of the quotient by N of said determined current value of the second parameter; and

- reconstructing the current value of a first parameter corresponding to the received data, on the basis of the one of the three terms $var_{modN_received} + N \times zone_R - N$, $var_{modN_received} + N \times zone_R$ and $var_{modN_received} + N \times zone_R + N$ which is comprised between $V_R - V_{min}$ and $V_R + V_{max}$,

wherein V_R is said determined current value of the second variable parameter and $var_{modN_received}$ is the result of said variable value modulo N indicated by said received data.

A method according to the invention makes use of knowing the value of a maximum deviation between values of variable parameter(s) for optimising the encoding, by transmitting the value of the parameter to be passed on modulo this maximum deviation. The receiving station reconstructs the non-transmitted portion according to the maximum deviation, and from a variable parameter value determined upon receiving the encoded data. The size of the data to be transmitted is thereby reduced.

In embodiments, the telecommunications method according to the invention further includes one or more of the following features:

- $N = V_{min} + V_{max} + 1$;

- the transmitting, respectively receiving station is a radio transmitting, respectively radio receiving station;

- the transmitting and receiving stations are nodes of an ad hoc network;

- a first variable value parameter, respectively a second variable parameter represents a geographical position coordinate of the transmitting station, respectively of

the receiving station and V_{min} , equal to V_{max} , represents the operational radio range of a radio transmitting and/or receiving station;

- a first variable value parameter represents past time data, a second variable parameter represents the reception time by the receiving station of the transmitted data, V_{min} represents the maximum age of said past time data and V_{max} represents the maximum advance of a clock of the receiving station relatively to the transmitting station;

- a first variable value parameter represents future time data, a second variable parameter represents the reception time of transmitted data by the receiving station, V_{min} represents the maximum delay of a clock of the receiving station relatively to the transmitting station and V_{max} represents the maximum anticipation of said future time data; and

- the first variable value parameter represents a record number in a base of the transmitting station a second variable parameter represents the last record number stemming from the transmitting station and received by the receiving station, V_{min} is zero and V_{max} represents a maximum number of record updates of said base not received by the receiving station.

According to a second aspect, the present invention proposes a processing module for a data transmitting station defining a value of at least one first variable value parameter V , intended for a receiving station, the value V such that it is located in the range $[V_r - V_{min} ; V_r + V_{max}]$, with V_{min} and V_{max} being set, said module being characterised in that it comprises:

- means for determining the current value of said first parameter relative to the transmitting station;

- means for calculating the result of said determined variable value modulo N , wherein N is a function of $V_{min} + V_{max}$; and

- means for controlling the transmission by the transmitting station of the data indicating the result of said variable value modulo N .

According to a third aspect, the present invention also proposes a processing module for a data receiving station indicating a representative value of a variable value V of at least one first parameter, transmitted by a transmitting station, the value V being such that it is located in the range $[V_R - V_{min} ; V_R + V_{max}]$, with V_{min} and V_{max} being set and V_R being a current value of a second variable parameter determined by the receiving station upon receiving the data, said module characterised in that it comprises:

- means for receiving said data;

- means for determining the current value of the second variable parameter relative to the receiving station, upon said reception of the data by the receiving station;

- means for determining the integer part, called $zone_R$ hereafter, of the quotient by N of said determined current value of the second parameter; and

- means for reconstructing the current value of the first parameter corresponding to the received data, on the basis of the one of the three terms $var_{modN_received} + N \times Zone_R - N$, $var_{modN_received} + N \times zone_R$ and $var_{modN_received} + N \times Zone_R + N$ which is comprised between $V_R - V_{min}$ and $V_R + V_{max}$,

wherein N a function of $V_{min}+V_{max}$, V_R is said determined current value of the second variable parameter and $var_{modN_received}$ is said received representative value of the variable value.

According to fourth aspect, the present invention relates to a computer programme intended for a data transmitting station defining one value of at least one first variable value parameter V , intended for a receiving station, said computer programme being characterised in that it comprises instructions for applying the steps, which are the responsibility of the transmitting station, of a method according to the first aspect of the invention, when the programme is executed on calculation means of the transmitting station, the value V being such that it is located in the range $[V_R - V_{min} ; V_R + V_{max}]$, with V_{min} and V_{max} being set and V_R being a current value of a second variable parameter determined by the receiving station upon receiving the data.

Finally, according to a fifth aspect, the present invention proposes a computer programme intended for a station receiving data representative of a value of at least one first variable value parameter V , transmitted by a transmitting station, said computer programme being characterised in that it comprises instructions for applying the steps, which are the responsibility of the receiving station of a method according to the first aspect of the invention, when the program is executed on calculation means of the receiving station, the value V being such that it is located in the range $[V_R - V_{min} ; V_R + V_{max}]$, with V_{min} and V_{max} being set and V_R being a current value of a second variable parameter determined by the receiving station upon receiving the data.

These features and advantages of the invention will become apparent upon reading the description which follows, only given as an example, and made with reference to the appended drawings, wherein:

- fig. 1 illustrates a radio frequency transmitter/receiver station applying the invention;
- fig. 2 illustrates an ad hoc network implementing the invention;
- fig. 3 is a flowchart of a method in an embodiment of the invention;
- fig. 4 illustrates by means of various examples a step of the flowchart of fig. 2.

In fig. 1 is illustrated an armoured vehicle 1 provided with a communications station 2 intended to form a node of an ad hoc network.

A communications station 2 includes a processing module 5, a GPS 6 and a memory 7.

5 The memory 7 includes a database 8.

The processing module 5 is suitable for driving the operation of the different components of the node 2 and notably includes a microprocessor on which are executed software packages stored in memory 7.

10 A communications station 2 further includes, with view to exchanging signal frames with a neighbouring node via a shared radio channel, a radio frequency transmission/reception radio module 3 connected to an antenna 4.

(The shared radio channel 2 allocated to the node may be predetermined, or selected by the station 2 from a list for example stored in the memory 7 according to various criteria notably resulting from signalling exchanges with neighbouring nodes.

15 The radio module 3 comprises a layer for access to the MAC (Medium Access Control) medium, a base band physical layer, a radio frequency physical layer. The radio module 3 is suitable, under the control of the processing unit 5, for the receiving and processing a radio frequency signal from the antenna 4 or allowing elaboration and transmission of a radio frequency signal from the antenna 4.

20 In an embodiment, the exchanged signals are compliant with the protocol IEEE 802.11 or with non-standardised protocols in effect in the field of military radio communications, and for example include voice communication data, messages of the SMS, MMS or instantaneous messaging type.

(In the relevant embodiment, the radio module 3 is suitable for operating in a half-duplex communications mode under the control of processing module 5.

 In the relevant embodiment the radio module 3 is further suitable for operating in reception and/or in transmission, on a signal radio channel at a time.

30 In a communications cycle, the radio node 2 is suitable, in a transmission phase for transmitting information notably including an identifier and optionally indicating its presence and/or the data to be relayed and/or data indicating its localisation.

 In a reception phase of the communication cycle the radio node 2 is suitable for receiving information on the radio channel which is allocated to it indicating the presence of other nodes in radio proximity, and/or data to be relayed, and/or data indicating the localisation of other nodes.

35 In the relevant embodiment, the node 2 updates its database 8 by recording therein, in a list of radio neighbours, the identifiers of the nodes which are within its radio

range, i.e. which have indicated their presence on the radio channel on the one hand and by recording therein the localisation of the nodes concerning which it has received localisation data on the other hand.

The communications station 2 is suitable for regularly applying under the control of the processing module 5, a broadcasting function f_{loc} 9, for localisation of the station. This function is applied following the execution on the microprocessor of the processing module 5, corresponding software as functions stored in the memory 7. It comprises the control for localising the station at the GPS module 6, the determination of the localisation of the station 2 by the GPS module 6 for example as a set of data (latitude X, longitude Y, often the altitude Z), calculation of encoded data by the function f_{calc_E} indicating this localisation, the elaboration of a message notably including these encoded data, and the transmission by the radio module 3 of the station 2, over a radio channel allocated to transmitting this elaborated message from the station 2, these steps being repeated for example at a frequency F_{loc} .

When the communication station 2 receives a message from another station notably including encoded data for localising this other station, it applies, under the control of the processing module 5, the calculation by a function f_{calc_R} , of the localisation information of this other station notably depending on the received encoded data.

The software functions f_{calc_E} and f_{calc_R} are applied following execution on the microprocessor of the processing module 5, of corresponding software instructions stored in the memory 7.

Fig. 2 illustrates a military intervention area 45 over which armoured vehicles operate. These vehicles 20, 21, 22, 23 are similar to the armoured vehicle 1 illustrated in fig. 1 and transport respective allied military teams.

These vehicles give rise to establishing an ad hoc network of nodes, 50.

In a known way, an ad hoc network is without any set infrastructure and the stations equipped with radio transmission and/or reception means and with adequate protocols, form the nodes of the network and communicate together step by step via a radio channel, or several shared radio channels.

Below, the vehicle and the node which it contains are identified with the same references. Moreover, a module of a node identified in fig. 1 with reference 3 to 8 will be identified below with the same reference, indexed by the reference of the relevant node as used in fig. 2: thus, the processing module of the node 20 will be identified below with reference 5₂₀.

The nodes 20, 21, 22, 23 of the ad hoc network 50 communicate together step by step via a same radio channel r1. Any two nodes from the nodes 20, 21, 22, 23, 24 may

communicate with each other by transmitting data over the channel r1, either directly when they are within radio range from each other, or by relaying via one or several other nodes of the network 50.

Direct radio links are established between the nodes within radio range from each other, either between the nodes 20 and 21, the nodes 21 and 23, the nodes 20 and 23, the nodes 23 and 22.

The communications protocol applied in the network is for example of the OLSR ("Optimized Link State Routing Protocol") type.

In a preliminary phase, the maximum radio range D of any node of the network 50 under conditions of operational use is determined (for example $D = 45\,000\text{ m}$). It will be noted that this theoretical range may be modified depending on the characteristics of the intervention area (for example an urban area, or not, etc) and that it may further include a margin in order to take into account the measurement accuracy of the localisation with the GPS module and the latencies generated by radio transmission.

The desired accuracy for each localisation data to be transmitted, i.e. P_X for the latitude datum X, P_Y for that of longitude Y and P_Z for that of altitude Z is defined ($P = P_X = P_Y = P_Z = 6\text{ m}$).

The integer part of $((D/P) + 0.5)$, is designated as, i.e. $K = E[(D/P) + 0.5]$, the term of 0.5 giving the possibility of selecting the integer which approximates best D/P fraction.

K represents the value of the radio range at accuracy P. In an embodiment, the values of D and P will be selected so as to obtain for N a value equal or close to an integer power of 2, with $N = (2 \times K + 1)$. N represents the diameter of the centre disk of a receiving node containing all the nodes within a radio range of said receiving node, therefore N represents the maximum distance between two such nodes.

In the relevant embodiment, it is considered that the value of the maximum operational range D is known to each station. For example it is stored in the memory 7.

The steps applied during the execution of the software instructions of the function of $f_{\text{calc_E}}$ on the microprocessor of the processing module 5 are described below, with reference to a transmitting node E, for example node 20, the GPS module 6 of the transmitting node E having determined the latitude X_E and the longitude Y_E corresponding to a current position of the node E. Optionally, the altitude Z_E is determined.

For each latitude X_E or longitude Y_E localisation parameter, the value of which is to be transmitted, steps 100 to 102 are successively carried out.

In step 100, the value of the relevant parameter i in metres is expressed, with $j = X_E, Y_E$.

With reference 100_j is designated the step 100 specifically applied for the parameter i , with $j = X_E, Y_E$.

Thus, in step 100_x, the angular measurement X_E of the measured latitude is converted into a measurement in metres of the cord on the meridian corresponding to the longitude Y_E on which is localised the station 20, from the south pole up to latitude X_E and the value in metres is thereby obtained, which, divided by the desired accuracy P , gives LatitudeMetre_E.

In step 100_y, the angular measurement Y_E of the measured longitude is converted into a measurement in metres of the cord on the parallel, corresponding to the latitude X_E from the meridian corresponding to -180° as far as the longitude Y_E and a value is thereby obtained which, divided by the desired accuracy P , gives LongitudeMetre_E.

The value in metres obtained at the end of step 100 is designated as ValMetre_E, Valmetre_E being equal in the relevant example to LatitudeMetre_E or LongitudeMetre_E according to the relevant parameter, X_E or Y_E , respectively.

In a step 101, the following calculation is performed: ModuloVal_E = ValMetre_E modulo N .

ModuloVal_E is equal to a positive integer comprised in the set $\{0, \dots, N-1\}$ equal to $\text{ValMetre}_E - \text{ValMetre}_E \times E[\text{ValMetre}_E/N]$, wherein $E[\]$ is the function integer part.

Thus, if the relevant parameter is latitude X_E , the value ModuloLatitude_E = LatitudeMetre_E modulo N is thereby obtained and if the relevant parameter is longitude Y_E , the value ModuloLongitude_E = LongitudeMetre_E modulo N is thereby obtained.

In a step 102, the value ValMetre_E is coded by means of n bits, with $n = \text{Ceiling}[(\text{Log}N/\text{Log}2)]$, wherein Ceiling is a function which returns the integer equal to or immediately greater than its argument.

Once steps 100 to 102 have been carried out for each position parameter X and Y , the transmitting node E transmits a message over the radio channel $r1$.

This message for example includes the identifier of the transmitting node E , here node 20, followed by the information of the date and time group (abbreviated as GDH), values ModuloLatitude_E, ModuloLongitude_E and optionally the altitude Z_E , accuracies P_x , P_y , P_z , of the speed and course of the vehicle including the transmitting node.

Each node of the network 50 within radio reach from the transmitting node E directly receives this message, this is a receiving node R .

The steps 200 and 203 applied during the execution of the software and its functions of the function f_{calc_R} on the microprocessor of the processing module 5 for reconstructing the information for localising the transmitter E from encoded localisation data ModuloVal_E are described below, with reference to a receiving node R , for example

node 21 or node 23, the GPS module 6 of each receiving node R having determined the latitude X_R , the longitude Y_R corresponding to the current position of the node R.

In step 200, the value of the relevant parameter (latitude X_R , longitude Y_R in metres) is expressed in the same way as described with reference to step 100.

5 The value in metres obtained at the end of step 200 is called $ValMetre_R$, $Valmetre_R$ being equal in the relevant example to $LatitudeMetre_R$ or $LongitudeMetre_R$ depending on the relevant parameter, X_R or Y_R .

In step 201, the receiving node R determines its zone value for the relevant parameter: $ZoneVal_R = E[ValMetre_R/N]$.

10 Thus, depending on whether the considered parameter is the latitude X_R or the longitude Y_R , is determined:

$ZoneLatitude_R = E[LatitudeMetre_R/N]$ or $ZoneLongitude_R = E[LongitudeMetre_R/N]$.

Next, in step 202, the receiving node R reconstructs the integral value of the relevant localisation parameter of the transmitting node.

15 The receiving node R is not aware of the zone of the transmitting node E (which defines the portion of the localisation parameter which has not been transmitted, i.e. $N \times ZoneVal_E = N \times E[ValMetre_R/N]$).

However, for reasons of maximum radio range, the width of a zone having the double value of this radio range, the zone of the transmitting node E is necessarily adjacent to the zone of the receiving node R.

20 Therefore, the zone of the transmitting node E for the relevant parameter being $ZoneVal_E = E[ValMetre_E/N]$ (according to whether the relevant parameter is latitude X_E or la longitude Y_E : $ZoneLatitude_E = E[LatitudeMetre_E/N]$, $ZoneLongitude_E = E[LongitudeMetre_E/N]$, one has:

25 $ZoneVal_{E1} = ZoneVal_R - 1$ or

$ZoneVal_{E2} = ZoneVal_R$ or

$ZoneVal_{E3} = ZoneVal_R + 1$.

And only one of these three cases verifies that the resulting distance between the transmitting node E and the receiving node R is actually less than the radio range K (cf demonstration below).

30 Therefore, in step 202, the receiving node R selects that of the 3 formulae $ZoneVal_{Ei}$ with $i = 1$ to 3, verifying that the absolute value of $(Valmetre_R - ModuloVal_{Ei} - N \times ZoneVal_{Ei})$ is actually less than D/P . The index i corresponding to the selected formula is called $i0$.

35 To do this, in step 203, the value of the relevant parameter is reconstructed by the receiving node:

$$\text{ValMetre}_E = \text{ModuloVal}_E + N \times \text{ZoneVal}_{E10}.$$

The value of the relevant parameter thereby expressed in metres is multiplied by the accuracies P and optionally converted into an angular value subsequently.

In fig. 4, different examples of the selection step 202 are illustrated.

5 Three zones extend along the horizontal axis: zone $n-1$, zone n and zone $n+1$.

The selected values are the following, notably the radio range is 4 and the accuracy is 1 i.e.:

$$D=4$$

$$P=1$$

10 $K=4$

$$N=9$$

$$N=4.$$

(In each zone, the possible values taken by the data ModuloVal_E are $\{0, 1, \dots, N-1\}$ i.e. $\{0, 1, \dots, 8\}$.

15 In section A, the latitude or longitude parameter encoded data received from the transmitter E have the value 4 and the receiver R is in the zone n and has the corresponding parameter value in a first case $0 + n \times N$.

Therefore E is either in the zone $n-1$, or n , or $n+1$.

20 Now, the distance between the node E and the node R should be less than $K=4$ (radio range at accuracy P), the node E can only be in the zone n , since the distances between the node R and each of the points located in position 4 in the zones $n-1$ and $n+1$ are greater than 5.

(25 In the second relevant case of the section A, the receiver R is in the zone n and has the corresponding parameter value $8 + n \times N$. There again, the distance between the node E and the node R should be less than 4, the node E can only be in the zone n , since the distances between the node R and each of the points located in position 4 in zones $n-1$ and $n+1$ are greater than 5.

30 In section B, the encoded data of the latitude or longitude parameter received from the transmitter E have the value 5 and the receiver R in a first case is in the zone n and has the corresponding parameter value $1 + n \times N$.

Therefore E is either in the zone $n-1$, or n , or $n+1$.

The distance between the node E and the node R should be less than 4, the node E can only be in the zone n , since the distances between the node R and each of the points located in position 4 in the zones $n-1$ and $n+1$ are greater than 5.

In the second relevant case of the section B, the receiver R is in the zone $n+1$ and has the corresponding parameter value $0 + (n+1) \times N$. There again, the distance between the node E and the node R should be less than 4, the node E can only be in the zone n .

In section C, the encoded data of the latitude or longitude parameter received from the transmitter E have the value 3 and the receiver R in a first case is in the zone $n-1$ and has the corresponding parameter value $8 + (n-1) \times N$.

Therefore E is either in the zone $n-1$, or n , or $n+1$.

The distance between the node E and the node R should be less than 4, the node E can only be in the zone n , since the distances between the node R and each of the points located in position 3 in the zone $n-1$ and $n+1$ are greater than 5.

In the second relevant case of the section C, the receiver R is in the zone n and has the corresponding parameter value $7 + n \times N$. There again, the distance between the node E and the node R should be less than 4, the node can only be in the zone n .

Hereafter, the demonstration is provided that a single parameter value is compliant with the radio range constraint among the 3 identified values (cf step 202).

Demonstration:

The demonstration is identical for the longitude and latitude values.

The position parameter of the receiving node R upon reception is written as

$$\text{ValMetre}_R = (2 \times K + 1) \times \text{ZoneVal}_R + \text{ModuloVal}_R$$

The value of ModuloVal_R is comprised in 0 and $2 \times K$.

The possible position parameter values of the transmitting node E are comprised between the limits:

$$E_{\min} = (2 \times K + 1) \times \text{ZoneVal}_R + \text{ModuloVal}_R - K$$

$$E_{\max} = (2 \times K + 1) \times \text{ZoneVal}_R + \text{ModuloVal}_R + K$$

Case 1: the receiving node R is found just in the middle of its zone ZoneVal_R .

In this case $r \text{ModuloVal}_R$ has the value K

$$\text{ValMetre}_R = (2 \times K + 1) \times \text{ZoneVal}_R + K$$

The possible relevant parameter values of the transmitting node E are comprised between:

$$E_{\min} = E - K = (2 \times K + 1) \times \text{ZoneVal}_R$$

$$E_{\max} = E + K = (2 \times K + 1) \times \text{ZoneVal}_R + 2 \times K$$

The receiving node R is therefore aware that the transmitting node E is found in its zone, $E_{\min}$ and $E_{\max}$ are just the limits of the zone ZoneVal_R .

Case 2: the receiver is found on the right of the middle of its zone ZoneVal_R

$$\text{ValMetre}_R = (2 \times K + 1) \times \text{ZoneVal}_R + K + d, \text{ with } d \text{ comprised between } 1 \text{ and } K.$$

The possible position parameter values of the transmitting node E are comprised between:

$$E_{\min} = E - K = (2 \cdot K + 1) \cdot \text{ZoneVal}_R + d$$

$$E_{\max} = E + K = (2 \cdot K + 1) \cdot (\text{ZoneVal}_R + 1) + (d - 1)$$

The value of the relevant parameter of the node E therefore can only be found in the zone of the relevant parameter of the receiving node R or in the one on the right.

Case 2a: the node E is found in the zone of the node R (for the relevant parameter)

$$\text{ValMetre}_E = (2 \cdot K + 1) \cdot \text{ZoneVal}_R + d + e$$

With e comprised between 0 and $(2 \cdot K - d)$ in order to remain in this zone

ModuleVal_E in this case has the value $(d+e)$, since N, the modulo value has the value $(2 \cdot K + 1)$. ModuloVal_E is transmitted by E

If the receiver R assumes that E is found in its right zone, then it estimates its position at the following value H:

$$H = (2 \cdot K + 1) \cdot (\text{ZoneVal}_R + 1) + (d+e)$$

The distance from E to R calculated by R has the value:

$$D = (2 \cdot K + 1) \cdot (\text{ZoneVal}_R + 1) + (d+e) - ((2 \cdot K + 1) \cdot \text{ZoneVal}_R + K + d)$$

$$D = K + 1 + e$$

D is always greater than K, the receiver therefore sets aside this selection and only retains that E is found in its zone

Case 2b: E is found in the zone on the right of the zone R

$$E = (2 \cdot K + 1) \cdot \text{ZoneVal}_R + 2K + 1 + e$$

The smallest possible value for E has the value 0.

If R assumes that E is found in its zone, then it estimates the position of E as being the following value H:

$$H = (2 \cdot K + 1) \cdot (\text{ZoneVal}_R + 1) + (d+e)$$

La distance de R to H has the value:

$$D = (2 \cdot K + 1) \cdot (\text{ZoneVal}_R + 1) + (d+e) - ((2 \cdot K + 1) \cdot \text{ZoneVal}_R + K + d)$$

$$D = 2 \cdot K + 1 + e - K = K + 1 + e$$

$D > K$, the receiver R sets aside this selection and retains the other possible selection in the zone on its right.

The other cases are inferred by symmetry.

In the relevant embodiment above, the invention has been applied relatively to geographical localisation data, the variable value parameter encoded at the transmitter being a piece of geographical localisation information of the transmitter, the variable value corresponding parameter at the receiver being a piece of geographical localisation

information of the receiver, the “modulo” of the function f_{calc_E} and the reconstruction of the function f_{calc_R} being applied on the basis of the maximum distance separating the transmitter and the receiver, equal to about twice the radio range, regardless of the geographical position.

Other methods for calculating a value in metres of the latitude and/or the longitude values may be used in step 100, provided that the same methods are also used by the receiver. The Earth may be approximated with a sphere, the radius of which is agreed upon between the transmitter and the receiver.

The invention has been described above relatively to latitude or longitude data. Of course it may be applied in the general case of a producer (or transmitter) E of data having the value V of a datum. This datum changes over time and should be transmitted from time to time to a consumer (or receiver) R of this datum.

The value of V represents depending on the embodiment, for example:

- the geographical position of the transmitter E, or
- the date of the detection of an event by the transmitter E, or
- the date of the next appointment that the transmitter E should propose to the receiver R, or
- the update number of a database record maintained by the transmitter E and transmitted to the receiver R.

The value of V should be transmitted with some accuracy. It is always possible to come back to the case when V is an integer value to be transmitted with an accuracy of one unit: this, by dividing the value V by the accuracy and by approximating the result by the closest integer. This is what is assumed in the following.

Let us assume that, in principle the receiver R is aware beforehand of a portion of the transmitted value, in that the receiver R is aware of a reference value V_{ref} which possibly varies over time and which permanently verifies:

$$V_{\text{ref}} - \text{OffsetMin} < V < V_{\text{ref}} + \text{OffsetMax}.$$

In the same way as demonstrated above, the sole reception of the value ‘V modulo N ’ = ModuloVal_E , which was calculated in a step similar to step 101 described above, is sufficient for the receiver R for it to reconstruct the value V, with $N = \text{OffsetMax} + \text{OffsetMin} + 1$.

The receiver then calculates its zone value similarly to what is described in step 201, by assuming $\text{ZoneVal}_R = E[V_{\text{ref}}/N]$, and then reconstructs the integral value of V similarly to what is described in step 202, while being aware that only one of the three solutions V verifies $V_{\text{ref}} - \text{OffsetMin} < V < V_{\text{ref}} + \text{OffsetMax}$.

As detailed above, in an application to a case of transmitting a position of a radio node, if the radio coverage has a range of K , then $\text{OffsetMin} = \text{OffsetMax} = K$ and $N = 2 \cdot K + 1$.

In an application to a case of transmitting date and time data of a past event, it being understood that it is forbidden that the transmitter E transmits to the receiver R date and time data of a too old event, one has:

V_{ref} = a local date and time as seen from the receiver R , upon receiving the data transmitted by the transmitter E , and

$$N = \text{MaxDecalageMontreR} + \text{AnciennetéMax} + 1;$$

wherein $\text{MaxDecalageMontreR}$ represents the maximum advance of the time of the receiver R relatively to the transmitter E (for example, $\text{MaxDecalageMontreR} = \text{OffsetMax} = E[(D_{\text{sup}}/P) + 0.5]$, wherein P has the value of the desired accuracy in seconds of the date and time transmitted data, D_{sup} is the maximum advance in seconds of the time of the receiver R relatively to the transmitter E)

and AnciennetéMax represents the maximum admissible age for transmitting the date of the event (for example, $\text{AnciennetéMax} = \text{OffsetMin} = E[(D_{\text{inf}}/P) + 0.5]$, wherein D_{inf} is the maximum admissible age in seconds).

It is assumed that the transmission time is negligible with respect to AnciennetéMax .

Example :

If the precision P of the date transmitted is the second, the maximum age is a time, and the delay from the local time of the receiver R compared to that of the transmitter E does not exceed one minute, then:

$$N = 60 + 3600 + 1 = 3661$$

When applied to a transmission of date and time data for a future event, it being understood that the transmitter E is prohibited from transmitting date and time information for an event too far in advance to the receiver R , the result is:

V_{ref} = the local date and time of the receiver R at the time of receipt of the data transmitted by the transmitter, and

$$N = \text{MaxDecalageMontreDR} + \text{AnticipationMax} + 1;$$

where $\text{MaxDecalageMontreDR}$ represents the max delay of the time of the receiver R compared to the transmitter E (e.g., $\text{MaxDecalageMontreDR} = \text{OffsetMin} = E[(D_{\text{inf}}/P) + 0.5]$, where P is the desired precision in seconds of the date and time data transmitted, D_{inf} is the maximum delay, in seconds, of the time of the receiver R compared to the transmitter E);

and AnticipationMax represents the amount of anticipation permissible for the transmission of the date of the event (e.g., $\text{AnticipationMax} = \text{OffsetMax} = E[(D_{\text{sup}}/P) + 0.5]$, where D_{sup} is the maximum anticipation in seconds).

It is assumed that the transmission time is negligible with respect to AnticipationMax.

Example:

If the accuracy of the transmitted date is the second, the maximum anticipation is one hour and if the offset of the local time of the receiver R relatively to that of the transmitter E does not exceed one minute, then:

$$N = 60 + 3600 + 1 = 3661$$

In an application to a case for transmitting an update number for a database record.

The transmitter E transmits from time to time the value of a record in its database. As the information channel is not reliable, the transmitter E sends in the same time the sequence number of the record so that the receiver R detects the loss of pieces of information.

Let us assume that operationally, it is impossible for the receiver R to be late with respect to the transmitter by more than M updates.

Then V_{ref} = the last received sequence number value (0 before any reception) and $N = M + 1$.

It is assumed that the transmission time is negligible with respect to the production rate of the successive recordings.

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CLAIMS

1. A telecommunications method from a transmitting station (20), for data defining a value of at least one first variable value parameter V , intended for a receiving station (21, 23), said method being characterised in that it comprises the following steps, the value V being such as it is located in the range $[V_R - V_{min} ; V_R + V_{max}]$, with V_{min} and V_{max} being set and V_R being a current value of a second variable parameter determined by the receiving station upon receiving the data:

- determining, by the transmitting station, the current value of said first parameter;
- calculating, by the transmitting station, the result of said variable value determined modulo N , wherein N depends on $V_{min}+V_{max}$;
- transmitting by the transmitting station, data indicating the result of said variable value modulo N ;

- receiving, by the receiving station, said data;
- determining, by the receiving station, the current value of the second variable parameter, upon said reception by the receiving station;
- determining the integer part, called a $zone_R$ hereafter, of the quotient by N of said determined current value of the second parameter;

- reconstructing the current value of a first parameter corresponding to the received data, on the basis of that of the three terms so $var_{modN_received} + N \times zone_R - N$, $var_{modN_received} + N \times zone_R$ and $var_{modN_received} + N \times zone_R + N$ which is comprised between $V_R - V_{min}$ and $V_R + V_{max}$,

wherein V_R is said determined current value of the second variable parameter and $var_{modN_received}$ is the result of said variable value modulo N indicated by said received data.

2. The communications method according to claim 1, according to which $N = V_{min}+V_{max} +1$.

3. The communications method according to claim 1 or 2, according to which the transmitting (20), respectively receiving (21, 23) station is a radio transmitting, respectively radio receiving station.

4. The communications method according to one of the preceding claims, according to which the transmitting and receiving stations (20, 21, 23) are nodes of an ad hoc network.

5. The communications method according to one of the preceding claims, according to which a first variable value parameter, respectively a second variable parameter represents a geographical position coordinate of the transmitting station, respectively of the receiving station and V_{min} , equal to V_{max} , represents the operational radio range of a radio transmitting and/or receiving station.

6. The communications method according to one of the preceding claims, according to which a first variable value parameter illustrates past time data, a second variable parameter represents the time of the reception of the transmitted data by the receiving station, V_{min} represents the maximum age of said past time data and V_{max} represents the maximum advance of a clock of the receiving station (21, 23) with respect to the transmitting station (20).

7. The communications method according to one of the preceding claims, according to which a first variable value parameter represents future time data, a second variable parameter represents the time of reception of the transmitted data by the receiving station, V_{min} represents the maximum delay of a clock of the receiving station with respect to the transmitting station and V_{max} represents the maximum anticipation of said future time data.

8. The communications method according to one of the preceding claims, according to which a first variable value parameter represents a record number in a base of the transmitting station (20), a second variable parameter represents the last record number from the transmitting station and received by the receiving station (21, 23), V_{min} is zero and V_{max} represents a maximum number of record updates of said base, not received by the receiving station.

9. A processing modules (5, 10) for a station (20) transmitting data defining a value of at least one first variable value parameter V , intended for a receiving station (21, 23), the value V being such that it is located in the range $[V_R - V_{min} ; V_R + V_{max}]$, with V_{min} and V_{max} being set, and V_R being a current value of a second variable parameter determined by the receiving station upon receiving the data, said module being characterised in that it comprises:

- means (6) for determining the current value of said first parameter relatively to the transmitting station;

- means (10) for calculating the result of said determined variable value modulo N, wherein N depends on $V_{min}+V_{max}$;

- means (10) for controlling the transmission of the data by the transmitting station, indicating the result of said variable value modulo N.

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10. The processing modules (5, 10) according to claim 9, wherein $N = V_{min}+V_{max} + 1$.

11. The processing modules (5, 10) according to claim 9 or 10, wherein:

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- a first variable value parameter represents a geographical position coordinate of the transmitting station (20) and V_{min} equal to V_{max} , representing the operational radio range of a radio transmitting and/or receiving station (20, 21, 23); and/or

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- a first variable value parameter represents past time data, V_{min} represents the maximum age of said past time data and V_{max} represents the maximum advance of a clock of the receiving station with respect to the transmitting station; and/or

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- a first variable value parameter represents future time data, V_{min} represents the maximum delay of a clock of the transmitting station and V_{max} represents the maximum anticipation of said future time data; and/or

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- a first variable value parameter represents a record number in a base of the transmitting station, V_{min} is zero and V_{max} represents a maximum number of record updates of said base, not received by the receiving station.

12. A processing module (5, 11) for a station receiving data indicating a representative value of a variable value V of at least one first parameter, transmitted by a transmitting station, the value V being such that it is located in the range $[V_R - V_{min} ; V_R + V_{max}]$, with V_{min} and V_{max} being set and V_R being a current value of a second variable parameter determined by the receiving station upon receiving the data, said module being characterised in that it comprises:

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- means for receiving said data;

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- means for determining the current value of the second variable parameter relatively to the receiving station, upon said reception of the data by the receiving station;

- means for determining the integer part, called $zone_R$ hereafter, of the quotient by N of said determined current value of the second parameter;

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- means for reconstructing the current value of the first parameter corresponding to the received data, on the basis of the one of the three terms $var_{modN_received} + N \times zone_R -$

N , $\text{var}_{\text{modN_received}} + N \times \text{zone}_R$ and $\text{var}_{\text{modN_received}} + N \times \text{zone}_R + N$ which is comprised between $V_R - V_{\min}$ and $V_R + V_{\max}$,

wherein N depends on $V_{\min} + V_{\max}$, V_R is said determined current value of the second variable parameter and $\text{var}_{\text{modN_received}}$ is said received representative value of the variable value.

13. The processing modules (5, 11) according to claim 12, according to which $N = V_{\min} + V_{\max} + 1$.

14. The processing modules (5, 11) according to one of claims 12 or 13, wherein:
- a second variable parameter represents a geographical position coordinate of the receiving station and $V_{\min}$, equal to $V_{\max}$, represents the operational radio range of a radio transmitting and/or receiving station; and/or

- a second variable parameter represents the time of reception of the transmitted data by the receiving station, $V_{\min}$ represents the maximum age of said past time data and $V_{\max}$ represents the maximum advance of a clock of the receiving station with respect to the transmitting station; and/or

- a second variable parameter represents the time of reception of the transmitted data by the receiving station, $V_{\min}$ represents the maximum delay of a clock of the receiving station with respect to the transmitting station and $V_{\max}$ represents the maximum anticipation of said future time data; and/or

- a second variable parameter represents the last record number from the transmitting station and received by the receiving station, $V_{\min}$ is zero and $V_{\max}$ represents a maximum number of record updates of said base, not received by the receiving station.

15. A computer programme (10) intended for a station (20) transmitting data defining a value of at least one first variable value parameter V , intended for a receiving station, said computer programme being characterised in that it comprises instructions for applying the steps, which are the responsibility of the transmitting station, of a method according to any of claims 1 to 8, when the programme is executed on computing means of the transmitting station, the value V being such that it is located in the range $[V_R - V_{\min}; V_R + V_{\max}]$, with $V_{\min}$ and $V_{\max}$ being set and V_R being a current value of a second variable parameter determined by the receiving station upon receiving the data.

16. A computer programme (11) intended for a station (21, 23) receiving representative data of a value of at least one first variable value parameter V , transmitted by a transmitting station, said computer programme being characterised in that it comprises instructions for applying the steps, which are the responsibility of the receiving station, of a method according to any of claims 1 to 8 when the programme is executed on the computing means of the receiving station, the value V being such that it is located in the range $[V_R - V_{\min} ; V_R + V_{\max}]$, with $V_{\min}$ and $V_{\max}$ being set and V_R being a current value of a second variable parameter determined by the receiving station upon receiving the data.