

Communication method with computation of a path from elementary networks, related computer program, interconnection node and radio station

The present invention relates to a communication method within a communication system comprising a plurality of elementary networks and one or several interconnection nodes, each elementary network including several radiocommunication nodes connected to each other through radiocommunication links according to a same radiocommunication protocol, two neighboring elementary networks being connected via one or several interconnection nodes, the method being applied for each interconnection node.

The present invention also relates to a computer program comprising software instructions, which when they are executed by a processor apply such a method.

The present invention also relates to an interconnection node intended to be connected to at least one elementary network within a communication system comprising a plurality of elementary networks and one or several interconnection nodes, said interconnection node being configured for applying such a method.

The present invention also relates to a radiocommunication station comprising such an interconnection node and one or several radiocommunication nodes.

The invention then relates to the field of radiocommunications within a communication system comprising several radiocommunication networks, the radiocommunication networks being preferably networks ad hoc. In a known way, a network ad hoc is without any fixed infrastructure.

Networks ad hoc are notably used for applying tactical communications between mobile military teams on combat areas. The radiocommunication nodes and the interconnection nodes are then for example mobile, and used in military tactical telecommunication applications.

A routing method in such a communication system is known from document EP 2 337 284 B1. This routing method determines a logical topology of network interconnection nodes by using a routing protocol with link states, also called a pro-active routing protocol.

The computation of a transmission path of at least one data packet between a source node and destination node then consists of determining a succession of nodes through which each packet has to pass through from the source node as far as the destination node, the computation of this transmission path being carried out according to the determined topology of nodes.

However, such a routing method is not very adapted for unstable communication networks, i.e. networks for which the composition of nodes changes very frequently, in

particular networks operating in an UHF (*Ultra-High Frequency*) range, with radiofrequencies comprised between 300 MHz and 3,000 MHz. The instability of the state of the links is propagated in the communication system and generates a computing load, and a signaling traffic load, all the higher since the number of links between pairs of nodes is significant.

This computing and signaling load is all the more a penalty for the performances of the user services since the availability of the spectral resource required for applying UHF networks ad-hoc is limited. Further, this signaling should possibly be carried on elementary networks of the VHF (*Very-High Frequency*) types with radiofrequencies comprised between 30 MHz and 300 MHz, which are more stable but which generally provide a throughput which is much less than that of UHF networks, so that the instability of the UHF networks causes congestion of the VHF networks.

The object of the invention is therefore to propose a communication method which is more adapted, notably for unstable communication networks.

For this purpose, the object of the invention is a communication method within a communication system comprising a plurality of elementary networks and one or several interconnection nodes, each elementary network including several radiocommunication nodes connected with each other through radiocommunication links according to a same radiocommunication protocol, two neighboring elementary networks being connected via one or several interconnection nodes,

the method being applied by each interconnection node and comprising the following steps:

- determining a unique identifier for each elementary network to which the interconnection node is connected;

- transmitting each determined identifier to said elementary network(s) other than the elementary network corresponding to the determined identifier; and

- computing, from the identifiers of elementary networks, a path for transmitting at least one data packet between a source node and an destination node, the transmission path passing through one or several elementary networks, the source node and the destination node each being a node from among a radiocommunication node and an interconnection node.

The communication method according to the invention then gives the possibility, by calculating from the identifiers of elementary networks the transmission path between the source node and the destination node, the transmission path passing through one or

several elementary networks, of being less sensitive to instability of the communication system.

In other words, the topology of the communication system between elementary networks has a clearly greater stability than that of the topology between nodes.

5 Further, the communication method according to the invention allows a notable gain at the generated computing level, typically by a factor comprised between 3 and 10, because of a number of links between elementary networks which is much smaller than the number of links between nodes, and also because of better stability of the links between elementary networks as compared with links between nodes.

10 According to other advantageous aspects of the invention, the communication method comprises one or several of the following features, taken individually or according to all the technically possible combinations:

- the determination and transmission steps are again carried out in the case of a connection of a new elementary network to the interconnection node or else in the case of suppression of a connection between the interconnection node and a corresponding elementary network;

- the method further comprises, after the determination step and before the transmission step, the following step:

+ putting the determined identifier in a queue before its potential transmission to said or the other elementary networks;

the step for transmitting the determined identifier being canceled when the determined identifier is, during the queuing step, received by another interconnection node which is connected to the same elementary network(s) than said interconnection node;

25 - the method further comprises, after the determination step, the following step:

+ suppressing a received packet when the latter is received from another interconnection node connected to said same elementary network(s) than said interconnection node;

- the method further comprises, after the computing step, the following step:

30 + re-emitting a received packet when the latter has not been received beforehand from another interconnection node connected to the same elementary network(s) than said interconnection node, said packet then being reemitted towards the next elementary network, according to the computed transmission path;

- during the determination step, the unique identifier of the elementary network is determined depending on a range of frequencies associated with the radiocommunication links connecting the radiocommunication nodes of the elementary network, on a communication channel associated with said radiocommunication links and on at least one address of a radiocommunication node of the elementary network;

- the method comprises, during the step for computing the transmission path, the computation of a topology of the elementary networks within the communication system by using a routing protocol with link states between the elementary networks, and the transmission path is then computed from said topology;

- the computation of the topology of the elementary networks within the communication system is carried out again only when two elementary networks are no longer connected or else when two elementary networks are newly connected;

- each radiocommunication protocol is a protocol with time division multiple access (TDMA);

- within a same elementary network, each radiocommunication node is within radio range of at least one other radiocommunication node of said elementary network; and

- all the radiocommunication nodes of a same elementary network are configured for communicating via a single range of frequencies selected from among the VHF range and the UHF range.

The object of the invention is also a computer program comprising software instructions, which, when they are executed by a processor, apply a method as defined above.

The object of the invention is also an interconnection node intended to be connected to at least one elementary network within a communication system comprising a plurality of elementary networks and one or several interconnection nodes, each elementary network including several radiocommunication nodes connected to each other through radiocommunication links according to a same radiocommunication protocol, two neighboring elementary networks being connected via one or several interconnection nodes,

the interconnection node comprising:

- a determination module configured for determining a unique identifier for each elementary network to which said interconnection node is connected;

- a transmission module configured for transmitting each determined identifier to the elementary network(s) other than the elementary network corresponding to the determined identifier; and

- a computing module configured for computing, from identifiers of elementary networks, a transmission path of at least one data packet between a source node and an destination node, the transmission path passing through one or several elementary networks, the source node and the destination node each being a node from among a radiocommunication node and an interconnection node.

The object of the invention is also a radiocommunication station comprising an interconnection node and one or several radiocommunication nodes, wherein the interconnection node is as defined above.

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

-Fig. 1 is a schematic illustration of two radiocommunication stations according to the invention, connected to each other via a communication relay, each radiocommunication station comprising an interconnection node and two radiocommunication nodes;

-Fig. 2 is a schematic illustration of a communication system comprising a plurality of elementary networks and one or several interconnection nodes;

-Fig. 3 is a flowchart of a communication method according to the invention;

-Fig. 4 is a flowchart illustrating a particular aspect of the communication method of Fig. 3, relating to queuing, before its potential transmission, of a determined identifier of an elementary network, in order to avoid unnecessary sending of this identifier if this has already been carried out previously by another interconnection node;

-Fig. 5 is a flowchart illustrating a particular aspect of the communication method of Fig. 3, relating to the fact that a topology of the elementary networks within the communication system is again computed only when both elementary networks are no longer connected or else when two elementary networks are newly connected;

-Fig. 6 is a flowchart illustrating a particular aspect of the communication method of Fig. 3, relating to a processing operation carried out by an interconnection node receiving a data packet; and

-Fig. 7 is a schematic illustration of the communication system illustrating the aspect of Fig. 6.

In Fig. 1, two radiocommunication stations 10 are connected to each other via a communication relay 12.

Each radiocommunication station 10 comprises one or several transceiver modules 14, also called modems, one or several antennas 15 and an interconnection node 16. In the example of Fig. 1, each radiocommunication station 10 comprises an interconnection node 16, two transceiver modules 14 and two antennas 15.

5 The communication relay 12 and the transceiver modules 14 each form a radiocommunication node 18.

The communication relay 12 is known *per se*, and for example is a gateway for retransmitting data via radioelectric waves, connected between two respective transceiver modules 14 of both radiocommunication stations.

10 Each transceiver module 14 is known *per se*, and is connected to a respective antenna 15.

Each transceiver module 14 is for example a VHF/UHF transceiver module, adapted for operating either in the VHF range, in particular in the radiofrequency range 30 MHz-300 MHz, or in the UHF range, in particular in the radiofrequency range 300 MHz-
15 3,000 MHz, depending a respective command provided by the interconnection node 16 indicating to them the operating VHF or UHF mode.

Alternatively, one of the transceiver modules 14 is a VHF transceiver module adapted for operating in the VHF range, and the other transceiver module 14 is a UHF transceiver module adapted for operating in the UHF range.

20 Each interconnection node 16 is intended to be connected to at least one elementary network 20 within a communication system 22 comprising a plurality of elementary networks 20 and one or several interconnection nodes 16, as illustrated in Fig. 2. Each elementary network 20 includes several radiocommunication nodes 18 connected with each other through radiocommunication links 24 according to a same
25 radiocommunication protocol, two neighboring elementary networks 20 being connected via one or several interconnection nodes 16. Each radiocommunication protocol is for example a protocol with time division multiple access, also called TDMA protocol.

In the example of Fig. 2, the communication system 22 comprises three elementary networks 20, respectively noted as A, B and C, two neighboring networks A, B, and respectively B, C, being every time connected to each other through two
30 interconnection nodes 16.

The link between each interconnection node 16 and the associated elementary network 20 is bidirectional.

Each interconnection node 16 comprises, as illustrated in Fig. 1, a determination
35 module 30 configured for determining a unique identifier for each elementary network 20

to which said interconnection node 16 is connected, a transmission module 32 configured for transmitting each determined identifier towards the elementary network(s) 20 other than the elementary network 20 corresponding to the determined identifier, and a computing module 34 configured for computing, from identifiers of elementary networks 20, a transmission path 36 of at least one data packet between a source node and an destination node, the transmission path 36 passing through one or several elementary networks 20, the source node and the destination node each being a node selected from among a radiocommunication node 18 and an interconnection node 16.

In the example of Fig. 2, the transmission path 36 is illustrated in solid lines, and the source and destination nodes are each a respective interconnection node 16.

Additionally and optionally, each interconnection node 16 further comprises a queuing module 38 configured for putting into a queue the determined identifier before its transmission towards the other elementary network(s); the queuing module 38 being if necessary further configured for cancelling the transmission of the determined identifier when the determined identifier is, during said queuing, received from another interconnection node 16 which is connected to the same elementary network(s) 20 as said interconnection node 16.

Additionally and optionally, each interconnection node 16 further comprises en a suppression module 40 configured for suppressing a received data packet when the latter is received from another interconnection node 16 connected to the same elementary networks 20 as said interconnection node 16.

Additionally and optionally, each interconnection node 16 further comprises a reemission module 42 configured for reemitting a received data packet when the latter has not been received beforehand from another interconnection node 16 connected to the same elementary network(s) 20 as the interconnection node 16, each packet then being reemitted towards the next elementary network 20, according to the computed transmission path 36.

Each interconnection node 16 for example comprises a unit for processing information, not shown, preferably formed with a processor and a memory associated with the processor. The determination module 30, the transmission module 32, and the computing module 34 are then for example each achieved as a piece of software which may be stored in the memory and able to be executed by the processor. Additionally and optionally, the queuing module 38, the suppression module 40 and the reemission module 42 are for example also achieved each as a piece of software which may be stored in the memory and executed by the processor.

Alternatively, the determination module 30, the transmission module 32, the computing module 34, and if necessary the queuing module 38, the suppression module 40, and the reemission module 42 are each made as a programmable logic component, such as an FPGA (*Field Programmable Gate Array*), or as a dedicated integrated circuit, such as an ASIC (*Application Specific Integrated Circuit*).

Each interconnection node 16 corresponds to the layer 3 of the ISO model.

Each radiocommunication node 18 corresponds to level 2 of the ISO model. Each radiocommunication node 18 belongs to a single elementary network 20.

All the radiocommunication nodes 18 of a same elementary network 20 are for example configured for communicating via a single frequency range, such as a frequency range selected from among the VHF range and the UHF range.

Within a same elementary network 20, each radiocommunication node 18 is within radio range of at least one other radiocommunication node 18 of said elementary network 20.

The elementary networks 20 are identified by a transmission plane, this transmission plane for example depending on the radiocommunication frequencies used for transmitting the data, on the radiocommunication technology applied, such as VHF or UHF technology, or further such as a radiocommunication technology according to the 2G, 3G and/or 4G standard.

The unique identifier of the elementary network 20 is then for example determined depending on a range of frequencies associated with the radiocommunication links 24 connecting the radiocommunication nodes 18 of said elementary network 20, on a radiocommunication channel associated with said radiocommunication links 24 and on at least one address of a radiocommunication node 18 of the elementary network.

The unique identifier is then, for example, obtained by concatenation of a field containing said address of the radiocommunication node, such as a MAC address, of a second field containing the piece of information relating to the frequency channel, and a third field containing the piece of information relating to the technology used, for example relative to the range of frequencies associated with the radiocommunication links 24.

Two elementary networks 20 are considered as being connected, or further connected with each other, when they are connected via at least one interconnection node 16, the number of interconnection nodes 16 connecting two neighboring elementary networks 20 being variable and not affecting the topology of the elementary networks 20 within the communications system 22.

Each radiocommunication link 24 is bidirectional. Each radiocommunication link 24 within an elementary network is preferably a link applying a protocol time division multiple access protocol (TDMA). Each radiocommunication link 24 is adapted for transmitting the frequencies in the range of frequencies associated with the radiocommunication node 18 which it connects.

The determination module 30 is configured for determining the unique identifier of said or each elementary network 20 to which is connected the interconnection node 16, the determination module 30 of which is a part thereof. In other words, the determination module 30 is configured for building an identity of said or of each elementary network 20 to which is connected the interconnection node 16 to which belongs the determination module 30.

The transmission module 32 is then configured for transmitting each determined identifier, or further each built identity, intended for the elementary networks 20 other than the one for which the identifier was determined beforehand by the determination module 30. The transmission module 32 is preferably configured for sending this identifier, also called an identity, in a broadcast mode towards all these other elementary networks 20.

The computing module 34 is then configured for computing, from identifiers (or identities) of elementary networks 20, the transmission path 36 for each packet to be sent from a source node to a corresponding destination node, each computed transmission path 36 being defined by the elementary network(s) 20 through which it passes.

The computing module 34 is then preferably also configured for computing a topology of the elementary networks 20 within the communication system 22 by using a routing protocol with states of links between the elementary networks 20, the transmission path 36 then being computed from said topology. The routing protocol with states of links is known per se, for example from document EP 2 337 284 B1, and is not described again.

The computing module 34 is preferably configured for again carrying out the computation of the topology of the elementary networks 20 within the communications system 22 only when two elementary networks 20 are no longer connected to each other or else when two elementary networks 20 are newly connected with each other. In other words, as long as the connectivity between the elementary networks 20 taken in pairs does not vary, the topology of the elementary networks 20 within the communication system 22 is not re-computed.

In the case of receiving a message either indicating a disappearance of a link between an elementary network 20 to which the corresponding interconnection node 16 is

connected and an elementary network 20 adjacent to said elementary network, or further upon receiving a message indicating appearance of a link between said connected elementary network 20 and an adjacent elementary network 20, the computing module 34 is then configured for announcing a change in the topology of the elementary networks 20 within the communications system 22 only if a disappeared link was the last link between the connected elementary network 20 and the relevant adjacent elementary network or else if a link having appeared is the first link between the connected elementary network 20 and the relevant adjacent elementary network 20. In the other cases, the computing module 34 is configured for so as not to transmit the message received beforehand indicating such a disappearance/appearance of a link.

The queuing module 38 is configured for queuing the determined identifier (or identity) before transmitting it to the other elementary networks 20, this in order to avoid transmission of said determined identifier when this transmission has already been carried out by another interconnection node 16 which is connected to the same elementary networks 20 as said interconnection node 16.

Similarly, in order to avoid transmitting several times a same packet between two neighboring elementary networks 20 by different interconnection nodes 16 connecting both of these neighboring elementary networks, the suppression module 40 is configured for suppressing a received packet when the latter has already been received from another interconnection node 16 connected to the same elementary networks 20 as said interconnection node 16.

The reemission module 42 is itself configured so as to reemit a received packet when the latter has not been received beforehand from another interconnection node 16 connected to the same elementary networks 20 as said interconnection node 16, this reemission then giving the possibility of ensuring the transmission of said packet along the computed transmission path, from the source node as far as the destination node.

The operation of the communication system 22 comprising the elementary networks 20, and in particular interconnection nodes 16 connecting these different elementary networks 20, will from now on be explained with reference to Fig. 3 illustrating a flowchart of the communication method according to the invention, as well as with reference to Figs. 4 to 7 illustrating particular aspects of this communication method.

During an initial step 100, the interconnection node 16 determines, via its determination module 30, the unique identifier, also called an identity, of each elementary network to which it is connected, this from the moment when it has received from a corresponding radiocommunication node 18 a connexity of this elementary network 20,

i.e. a list of the radiocommunication nodes 18 forming this elementary network 20. The building of the identity of each elementary network 20 to which the interconnection node 16 is connected is carried out from pieces of information relating to at least one radiocommunication node 18 contained in the relevant elementary network 20.

5 The identity of said network is for example built with the smallest address MAC from among the MAC addresses of the radiocommunication nodes 18 contained in said network, with a piece of information relating to the frequency channel used in said network, and/or with a piece of information relating to the radiocommunication technology used in this elementary network, this technology for example being VHF technology, UHF
10 technology, or further a technology according to another radiocommunication standard, such as the 2G standard, the 3G standard, or the 4G standard.

 Alternatively, the address used is an address depending on the addresses, such as the MAC addresses, of all the radiocommunication nodes 18 contained in said elementary network 20. Still alternatively, the address used in the address, such as the
15 MAC address of the radiocommunication node 18 which is the most stable, i.e. the radiocommunication node 18 which statistically undergoes less change in connections with its neighborhood when the topology of the elementary network changes overtime.

 After the determination of the unique identifier of each elementary network 20 to which the interconnection node 16 is connected, also called construction of identity of
20 each elementary network (step 100), the interconnection node 16 passes to the step 110 for being into a queue, as illustrated in Fig. 4, or else directly to step 120 for transmission of the identifier, this queuing step 110 being optional, as illustrated in Fig. 3.

 During the queuing step 110, the interconnection node 16 put into a queue, via its queuing module 38, the determined identifier before transmitting it towards the other
25 elementary network(s) 20, this in order to avoid sending back this identifier if this has already been done previously by another interconnection node 16 connected to the same elementary networks 20 as it.

 During this queuing step 110, when the queuing module 38 notices that the determined identifier has already been received beforehand from another interconnection
30 node 16 which is connected to the same elementary networks 20 as the interconnection node 16 to which it belongs, it cancels the transmission of the determined identifier, and the corresponding step 120 is then not carried out. If necessary, the interconnection node 16 directly passes to the next step 130 for computing the transmission path 36.

 Otherwise, when the queuing module 38 notices that upon expiry of a predefined
35 time out corresponding to the queuing, the determined identifier has not been received

from another interconnection node 16 which is connected to the same elementary networks 20 as the interconnection node 16 to which it belongs, it then validates the transmission of said identifier to the other connected elementary networks 20, and the interconnection node 16 then switches to the following step 120 for transmitting the identifier.

During the transmission step 120, the sending of the identifier is preferably carried out in a broadcast mode towards all the other connected elementary networks 20, i.e. towards all the elementary networks 20 to which the interconnection node 16 is connected which are different from the elementary network 20 identified during step 100.

The determination 100 and transmission 120 steps are again carried out in the case of the connection of a new elementary network 20 to the relevant interconnection nodes 16 or in the case of suppression of a connection between the relevant interconnection node 16 and a corresponding elementary network 20.

During the computing step 130, the interconnection node 16 computes the transmission path 36 of each packet from a source node to a corresponding destination node, this via its computing module 34 and from the different identifiers of an elementary network 20 determined or received from other interconnection nodes, the transmission path 36 passing through one or several elementary networks 20 and being defined by said crossed elementary networks 20.

During this computing step 130, the computing module 34 preferably computes the topology of the elementary networks 20 within the communication system 22, for example by using the routing protocol with states of links. The computing module 34 then infers therefrom the transmission path 36 by selecting the shortest path from among the successive elementary networks 20 found between the source node and the destination node, this from the computed topology.

Preferably, the computation of said topology is again carried out only when two elementary networks 20 are no longer connected through at least one interconnection node 16 or else when two elementary networks 20 are newly connected through at least one interconnection node 16.

This is for example applied via a sequence of sub-steps as illustrated in the flowchart of Fig. 5. During a sub-step 132, the interconnection node 16 receives a message either indicating disappearance of a link between an elementary network 20 to which the interconnection node is connected and an adjacent elementary network 20 of said connected network, or on the contrary a message indicating the occurrence of a link between the connected elementary network and an adjacent elementary network 20, such

a link corresponding to the presence of an interconnection node 16 connecting said connected elementary network and said adjacent elementary network.

The computing module 34 therefore determines:

- a) when the message received during sub-step 132 is a message of the disappearance of a link between the connected elementary network and the corresponding adjacent elementary network, if the link having disappeared was the last link between the connected elementary network and the corresponding adjacent elementary network, and

- b) when the message received during the sub-step 132 is a message of occurrence of a link between the connected elementary network and the corresponding adjacent elementary network, if the link having appeared is the first link between said connected elementary network and said adjacent elementary network.

When the computing module 34 notices that one of the two aforementioned conditions a) and b) is verified, which then corresponds to a change in topology, it passes to the next sub-step 136 for announcing this change in topology to the other elementary networks 20 within the communications system 22.

Otherwise, if none of the two aforementioned conditions a) and b) is verified, this means that in spite of the disappearance or occurrence of a link, the connectivity between the connected elementary network and the adjacent elementary network has not changed, i.e. the global topology of the elementary networks 20 within the communication system 22 has not been modified, then the computing module 34 passes to the sub-step 138 and then blocks the transmission of the message, so that the message received during the sub-step 132 is not transmitted to the other interconnection nodes 16. Indeed, since the received message does not indicate a change in the topology, it is unnecessary to transmit it to the other interconnection nodes 16 of the communication system.

After the computing step 130, the interconnection node 16 passes to a next step 140 for handling the received packets, this handling step 140 for example including a sequence of sub-steps as illustrated in the flowchart of Fig. 6.

In the case of receiving from the interconnection node 16 a packet to be transmitted to a destination node (sub-step 142), the relevant interconnection node 16 begins by determining during the next sub-step 144 whether the sender of the packet is an interconnection node 16 either visible or not. An interconnection node 16 is considered as being visible with respect to the relevant interconnection nodes 16, if two interconnection nodes 16 are connected to a same common sub-set of elementary

networks 20, in other words if both interconnection nodes 16 are interconnection nodes connecting the same elementary networks 20.

If, during the sub-step 144, the relevant interconnection node 16 determines that the interconnection node 16 which has sent the received packet is a visible interconnection node, then it passes to the sub-step 146 during which it suppresses, via its suppression module 40, the received packet, the latter having already been received from another interconnection node 16 which is connected to the same elementary networks 20 as it, as this is illustrated in Fig. 7.

In the example of Fig. 7, the sender interconnection node 16, noted as N1, has sent a packet to the following interconnection nodes, noted as N2, N3 and N4 (arrows F1), via the elementary network 20 noted as A and along the transmission path 36 computed earlier. The interconnection nodes 16 noted as N2, N3 and N4 are three interconnection nodes 16 each connecting the elementary network 20 noted as A to another elementary network 20 noted as B, and the interconnection node 16 noted as N3 was the most rapid for transmitting the received packet to a next interconnection node 16, noted as N5, via the elementary network B and along the computed transmission path 36 (arrows F2). By then assuming that the relevant interconnection node 16 is the interconnection node noted as N2 or else the one noted as N4, then it will notice that during the sub-step 144 that the received packet from the interconnection node N1 (arrows F1) has also been received from the interconnection node N3 (arrows F2), and that the latter is an interconnection node connected to the same elementary networks A, B as it, and it will then suppress the packet during the sub-step 146, as symbolized by the cross-shaped symbol 'X' in Fig. 7.

If, during the sub-step 144, the relevant interconnection node 16 on the contrary determines that the sender interconnection node 16 is not a visible interconnection node, i.e. is not another interconnection node connected to the same elementary networks 20 as it, then it passes to the sub-step 148 during which it identifies the following interconnection nodes 16, and then generates during the sub-step 150 a corresponding datagram before sending it during the next sub-step 152 to the following interconnection nodes, as identified during the sub-step 148. The sub-steps 148, 150 and 152 are applied by the reemission module 42.

The datagram is a message comprising both the packet and the addresses of the following interconnection nodes 16, the packet as for it exclusively containing useful data.

In the example of Fig. 7, the application of the sub-steps 148, 150 and 152 corresponds to the one carried out by the interconnection node 16, noted as N3. Indeed, when the interconnection node N3 receives the packet from the sender interconnection

node N1 (arrows F1), it has not yet received it from the other interconnection nodes 16 connected to the same elementary networks A, B as it, i.e. from the interconnection nodes N2, N4. The interconnection node N3 then identifies the next interconnection node along the computed transmission path 36, in this case the interconnection node N5 in the example of Fig. 7, and then generates and sends the datagram towards the next interconnection node N5, as well as to the other interconnection nodes N2, N4 connected to the same elementary networks A, B as it (arrows F2).

Thus, the communication method and the interconnection node 16 according to the invention give the possibility of transmitting more simply and more efficiently a packet from a source node to an destination node by identifying a transmission path, also called a route, following successive elementary networks 20, while with the communication method according to the state of the art, the routing of the packets was carried out only from a topology of the nodes and by then identifying a route following the successive nodes, for example via a routing protocol with states of links.

The fact of computing, according to the invention, the route from identified elementary networks 20 gives the possibility of having a routing protocol which is less sensitive to a time-dependent change in the composition of nodes 16, 18 of the communication system 22, the routing protocol then being in particular independent of the number of interconnection nodes 16 between the pairs of neighboring elementary networks 20.

Further, with the communication method according to the invention, the topology of the elementary networks 20 within the communication system 22 is updated and transmitted within the communication system 22 exclusively if two elementary networks 20 which were connected previously to each other (via at least one interconnection node 16) are no longer connected, or else if two elementary networks 20 which up till now were not connected to each other are newly connected via at least one interconnection node 16. This then gives the possibility of significantly reducing the computations carried out for maintaining an update of the topology within the communication system 22, notably with respect to the communication method of the state of the art wherein it was necessary to permanently be aware of the links between all the nodes of the network, which was not then particularly adapted to unstable networks, in particular to UHF networks.

One skilled in the art will then notice that all the interconnection nodes 16 connecting two neighboring elementary networks 20 are potential relays for transmitting a packet via these two neighboring elementary networks 20, and that only the most rapid interconnection node 16 will actually be a relay, the transmission of the packet by the

other interconnection nodes 16 between both of these elementary networks is then stopped, as described earlier with reference to Figs. 6 and 7.

Complementarily, one skilled in the art will observe that the communication method according to the invention relates to a control plane on the one hand and to a data plane on the other hand. The aspects associated with the control plane are the unique identification of the elementary networks, i.e. the determination of the unique identifier made during step 100; the announcement by the interconnection nodes 16 of these elementary networks 20 and of the interconnection nodes 16 which are connected to it, corresponding to step 120 for transmitting each computed identifier; and the filtering of the loops in the case of an identical announcement received from several interconnection nodes 16 corresponding to step 110 for queuing with cancellation of transmission if required. A last aspect concerning the control plane is the computation of the transmission path 36, also called a route, with the successive elementary networks 20 through which the corresponding packet will have to pass.

The aspects relating to the data plane are the forwarding of the data along the route between the successive elementary networks 20 towards the relevant destination nodes; the sending of the packet towards all the interconnection nodes 16 between two neighboring elementary networks 20 connected along the computed route, corresponding to the arrows F1 of Fig. 7; the retransmission by the interconnection nodes 16 towards all the next interconnection nodes 16 of said packet, corresponding to the sub-step 152 of Fig. 6 and to the arrows F2 of Fig. 7. A last aspect concerning the data plane is the fact that a received packet is only relayed by the fastest interconnection node 16, as described with reference to Figs. 6 and 7, which causes suppression of the packet during the sub-step 146 of Fig. 6 when the relevant interconnection node 16 has received the packet via a given elementary network 20 and that this same packet is waiting to be transmitted towards this elementary network 20.

With reference to Figs. 2 and 7, a communication system was considered including two or three elementary networks 20. Of course, the invention may be applied in the case of any number N of elementary networks 20, N being an integer, which may be strictly greater than 2.

Elementary networks 20 based on UHF type or VHF type communications were mainly considered. Of course, the invention may be applied with various types of communication protocols, such as the protocols associated with the 2G, 3G and/or 4G standards.

It is thus conceivable that the communication method and the interconnection node 16 according to the invention are more efficient and are in particular more adapted to unstable communication systems or networks.

CLAIMS

1. A communication method within a communication system (22) comprising a plurality of elementary networks (20) and one or several interconnection nodes (16), each elementary network (20) including several radiocommunication nodes (18) connected to each other through radiocommunication links (24) according to a same radiocommunication protocol, two neighboring elementary networks (20) being connected via one or several interconnection nodes (16),

the method being applied by each interconnection node (16) and being characterized in that it comprises the following steps:

- determining (100) a unique identifier for each elementary network (20) to which the interconnection node (16) is connected;

- transmitting (120) each determined identifier to the elementary network(s) other than the elementary network corresponding to the determined identifier; and

- computing (130), from identifiers of elementary networks, a transmission path (36) of at least one data packet between a source node and an destination node, the transmission path (36) passing through one or several elementary networks (20), the source node and the destination node each being a node from among a radiocommunication node (18) and an interconnection node (16).

2. The communication method according to claim 1, wherein the determination (100) and transmission (120) steps are again carried out in the case of connection of a new elementary network (20) to the interconnection node (16) or else in the case of suppression of a connection between the interconnection node (16) and a corresponding elementary network (20).

3. The communication method according to any of the preceding claims, wherein the method further comprises, after the determination step (100) and before the transmission step (120), the following step:

- putting into a queue (110) the determined identifier before its potential transmission to the other elementary network(s);

the step (120) for transmitting the determined identifier being canceled when the determined identifier is, during the queuing step (110), received from another interconnection node which is connected to the same elementary network(s) as said interconnection node (16).

4. The communication method according to any of the preceding claims, wherein the method further comprises, after the determination step (110), the following step:

5 - suppression (146) of a received packet when the latter is received from another interconnection node connected to the same elementary network(s) as said interconnection node.

5 5. The communication method according to any of the preceding claims, wherein the method further comprises, after the computing step (130), the following step:

10 - reemitting (152) a received packet when the latter has not been received beforehand from another interconnection node connected to the same elementary network(s) as said interconnection node, said packet then being reemitted towards the following elementary network, along the computed transmission path (36).

15 6. The communication method according to any of the preceding claims, wherein, during the determination step (100), the unique identifier of the elementary network is determined depending on a range of frequencies associated with the radiocommunication links connecting the radiocommunication nodes of the elementary network, on a communication channel associated with said radiocommunication links and on at least
20 one address of a radiocommunication node of the elementary network.

7. The communication method according to any of the preceding claims, wherein the method comprises, during the step (130) for computing the transmission path (36), the computation of a topology of the elementary networks (20) within the communication
25 system (22) by using a routing protocol with states of links between the elementary networks, and the transmission path (36) is then computed from said topology.

8. The communication method according to claim 7, wherein the computation of the topology of the elementary networks (20) within the communication system (22) is
30 again carried out only when two elementary networks (20) are no longer connected or else when two elementary networks (20) are newly connected.

9. The communication method according to any of the preceding claims, wherein each radiocommunication protocol is a time division multiple access protocol (TDMA).

10. The communication method according to any of the preceding claims, wherein, within a same elementary network (20), each radiocommunication node (18) is within radio range of at least one other radiocommunication node (18) of said elementary network.

11. The communication method according to any of the preceding claims, wherein all the radiocommunication nodes (18) of a same elementary network (20) are configured for communicating via a unique range of frequencies selected from among the VHF range and the UHF range.

12. A computer program comprising software instructions, which, when they are executed by a processor, apply a method according to any of the preceding claims.

13. An interconnection node (16) intended to be connected to at least one elementary network (20) within a communication system (22) comprising a plurality of elementary networks (20) and one or several interconnection nodes (16), each elementary network (20) including several radiocommunication nodes (18) connected to each other through radiocommunication links (24) according to a same radiocommunication protocol, two neighboring elementary networks (20) being connected via one or several interconnection nodes (16),

characterized in that it comprises:

- a determination module (30) configured for determining a unique identifier for each elementary network to which said interconnection node is connected;

- a transmission module (32) configured for transmitting each determined identifier to the elementary network(s) other than the elementary network corresponding to the determined identifier; and

- a computing module (34) configured for computing, from the identifiers of elementary networks, a transmission path (36) of at least one packet of data between a source node and an destination node, the transmission path (36) passing through one or several elementary networks (20), the source node and the destination node each being a node from among a radiocommunication node (18) and an interconnection node (16).

14. A radiocommunication station (10) comprising an interconnection node (16) and one or several radiocommunication nodes (18, 14), characterized in that the interconnection node (16) is according to the preceding claim.