Attachment method in an ad hoc mobile network based on cellular technology

The present invention relates to an attachment method in an ad hoc mobile network based on wireless cellular technology, and more particularly in a network of the type including a plurality of nodes, each node including an access point module, at least one relay terminal module and means for transmitting/receiving radio waves, the relay terminal module of a node being, at each moment, either not attached, or attached to an access point module of another node of the network.

One such network is for example described in document EP 1,936,872 A1, which constitutes the nearest prior art document.

"Wireless cellular technology" refers to a technology as defined by the Wi-Fi standard, the WiMAX standard, the LTE standard or standards of the same type.

The relay terminal module (RT module hereinafter) of a first node is able to initiate an attachment process to the access point module (AP module hereinafter) of a second node, which is situated in the wireless vicinity of the first node (i.e., in a coverage cell of the first node), the second node therefore being called a neighbor of the first node.

At each moment, the RT module of a node is either not attached, or attached to an AP module of another node of the network.

The AP module of a node is either not attached, or attached to an RT module, or attached to several RT modules.

Once an attachment is established, a two-way communication between the two attached nodes may occur. This attachment is ephemeral and may be broken at any time, either "voluntarily" by one of the nodes that "prefers" to attach itself to another node, or "involuntarily", when the attached nodes move away from each other and the quality of the established communication deteriorates.

The network is formed based on the attachments between the nodes.

At a given moment, the network has a technology defined by a graph representing the nodes and the attachments existing between those nodes. Such a graph is for example shown in figure 1.

In such a network, each node can relay a communication between a source node and a receiving node exchanging data. Each node is thus capable of routing a data stream.

According to the prior art, including document EP 1 936 872 A1, the establishment of an attachment between two nodes is generally done as described below.

The AP module of each node periodically emits a beacon signal.

In that case, the RT module of a node periodically discovers its wireless environment by searching for beacon signals and determines a list of neighboring nodes.

Then, the node selects the neighboring nodes to which it will attach itself based on a criterion such as the quality of the reception of the beacon signal, the predetermined hierarchy between the nodes of the network, the usage history of the network (the likelihood of attachment to a node depends on the number of attachments to that node in the past).

Once a neighboring node has been selected, the RT module is called to initiate the attachment process to the AP module of the selected neighboring node. The attachment process implemented between the RT module and the AP module depends on the cellular technology used. The attachment between two nodes leads to the creation of a link on layer 2, according to the OSI model for the description of the different layers of a network.

However, the decision made locally by an RT module to initiate or not initiate an attachment process to one neighboring node rather than another does not necessarily lead, at the network scale, to obtaining a maximum overall connectivity.

For example, as illustrated in figure 1, the network is subdivided into several sub-networks or components, independent of each other, although a node of one component is within range of a node of another component, and by establishing an attachment between those nodes, better network connectivity could be obtained. This case is shown in figure 1. Nodes 1 to 3 belong to a first component R1 of the network R, while nodes 4 to 12 belong to a second component R2 of the network R. No node of the first component can exchange data with a node of the second component. However, nodes 3 and 4 are within range. If an attachment existed between those two nodes, the overall connectivity of the network would *a priori* be improved, the number of pairs of nodes able to exchange data increasing.

Also for example, the successive attachments between the nodes of the network can lead to the path followed by a data stream from a source node to a receiving node, within a component, being longer than necessary. Thus, in the second component R2 of the network R shown in figure 1, the path between the node 12 and the node 10 is relatively long. However, the nodes 11 and 8 are within range, and if an attachment existed between those two nodes, the path between the nodes 12 and 10 would *a priori* be greatly reduced. The reduction of the average length of the paths participates in improving the overall connectivity of the network.

It is to be noted that, once the attachment method has been performed in order to build a specific network, defined by a graph, a routing method is performed in the network. Such a routing method, out of the perimeter of the present patent application, may for example be the method defined in document US 2003/179742 A1, in document WO 2010/019395 A1, or in document US 2011/164527 A1.

Thus, the invention aims to offset the aforementioned drawbacks associated with the attachment method, in particular by proposing an attachment method making it possible to improve the overall connectivity of the network.

The invention relates to an attachment method in an ad hoc mobile network based on wireless cellular technology, of the type including a plurality of nodes, each node including an access point module, at least one relay terminal module, a relay terminal module of one node being able to discover the access point module of neighboring nodes and initiate an attachment process with an access point module of a selected neighboring node, a relay terminal module of one node being attached at most to an access point module of a neighboring node, characterized in that it includes a step consisting of selecting a neighboring node to which a considered node must initiate an attachment process among the nodes from a list resulting from a discovery step, carried out by the relay terminal module of the considered node, and based at least on the connectivity information relative to the connected component of the considered node and at least a piece of connectivity information relative to the connected component of each neighboring node of the list.

Thus, whereas the method described in document EP 1 936 872 A1 is limited to avoid an attachment between an RT module and the AP module of the same node, the present attachment method is enriched with criterions for the selection of the neigbouring node and implements an algorithm allowing the maximization of the global connectivity between the nodes of the network.

According to specific embodiments, the method includes one or more of the following features, considered alone or according to any technically possible combinations:

- said at least one piece of connectivity information of a node is chosen from among a number (ni) of nodes present in the connected component of the node, a list of identifiers of the nodes present in the connected component of the node, and a graph of the connected component of the node.
- each node having a topology module storing a graph of the connected component of the node, the method includes a step for querying the topology module in order to obtain the current graph of the connected component of the node, a step for computing said at least one piece of connectivity information and a step for transmitting the or each computed piece of connectivity information.
- the transmission step consists of transmitting, via the access point module of said node, a beacon signal including the or each piece of connectivity information, and in that the method includes, during the discovery step by the relay terminal module of the considered node, a step for collecting the or each piece of connectivity information of a neighboring node whereof a beacon signal has been detected by said considered node.

- the step consisting of selecting a neighboring node includes a step for verifying that the neighboring node does not belong to the connected component of the considered node and, in the affirmative, a step for comparing the number of nodes present in the connected component of the neighboring node with the number of nodes present in the connected component of the considered node, the neighboring node being selected when the number of nodes in its connected component is greater than that of the connected component of the considered node.

- the step consisting of selecting a neighboring node includes a step for verifying that the neighboring node does not belong to the connected component of the considered node and, in the negative, a step for comparing, on the one hand, the mean length of the paths between the connected component of the considered node and, on the other hand, the mean length of the paths without the connected component of the considered node, modified such that the considered node is attached to the neighboring node, the neighboring node being selected when the mean length of the paths in the connected component of the modified considered node is smaller than the mean length (yi) of the paths in the connected component of the considered node.

- each node including a stream module maintaining a list of the data streams relative to the communications in progress relayed by said receiving node, the method includes, before a step consisting of commanding the relay terminal module of the considered node to initiate an attachment process to the access point module of the selected neighboring node, a step consisting of querying the stream module in order to obtain the list of streams in progress, determine the number of data streams in progress and verify that the number of streams in progress is below a predetermined threshold.

- the selection step is carried out at an operational unit, in communication with each of the nodes of the network and able to transmit, to a considered receiving node, the identifier of the selected neighboring node to which it must connect.

- the selection step is carried out at each node.

The invention relates to an information recording medium, characterized in that it includes the instructions for implementing attachment method as defined above, when those instructions are executed by a computer.

The invention relates to a system including a plurality of nodes, each node including an access point module, a relay terminal module of a node being able to discover the access point module of the neighboring nodes and initiate an attachment process with an access point module of a selected neighboring node, a relay terminal module of a node being attached to at least one access point module of a neighboring node, characterized in that it is able to carry out an attachment method according to the method described above, the

system including a selection means capable of selecting a neighboring node to which a considered receiving node must initiate an attachment process among the nodes from a list resulting from a discovery step, by the relay terminal module of the receiving node, and considering at least one piece of connectivity information relative to the connected component of the considered node and one piece of connectivity information relative to the connected component of the neighboring nodes mentioned in the list.

Preferably, the access point module of one node is able to send at least one piece of connectivity information relative to its connected component using a wireless transceiver means of the AP module or using a transceiver means of a radio technology other than that implemented for the ad hoc network.

The invention relates to a node including an access point module and at least one relay terminal module, the relay terminal module of the node being able to discover access point modules of neighboring nodes and initiate an attachment process with a module of an access point of a selected neighboring node, the relay terminal module of the node being attached at most to one access point module of a neighboring node, characterized in that it can be part of the system defined above.

The invention will be better understood, and other features, aims and advantages thereof will appear more clearly, using the following description of one particular embodiment of the invention and several possible embodiments, provided solely as an illustrative and non-limiting example, in reference to the appended drawings. In these drawings:

- Figure 1 diagrammatically shows the graph of an ad hoc mobile network based on wireless cellular technology;
- Figure 2 is a diagrammatic illustration of the structure of a node of a first embodiment of a system for implementing the attachment method according to the invention;
- Figure 3 is a diagrammatic block illustration of one embodiment of an attachment method according to the invention;
- Figures 4 and 5 are graphs respectively showing the evolution over time of the number of pairs of nodes able to communicate and the mean length of the paths in a network whereof the nodes implement the attachment method of figure 3; and
- Figure 6 shows a second embodiment of the system for implementing the method of figure 3.

An attachment method is implemented in a system including a plurality of nodes according to the node i diagrammatically shown in figure 2.

The node i includes an AP module 20, an RT module 30, an attachment module 40, a topology module 50 and a stream module 60.

In order to simplify the description, hereinafter, the access point module AP and the relay terminal module RT of the same node each include their own radio wave transceiver means. However, shared transceiver means may be considered.

Thus, the node i includes a radio signal transceiver means 22 associated with the AP module 20 and a radio transceiver means 32 associated with the RT module 30.

The AP 20 and RT 30 modules are according to those of the state of the art.

The AP module 20 is able to command its radio transceiver means to transmit a beacon radio signal periodically, incorporating a message in particular including connectivity information transmitted by the attachment module 40, as will be described below.

When an RT module 30 of a neighboring node j of the node i has detected such a beacon signal and responds to initiate an attachment process, the AP module 20 of the node i is able to carry out the steps of the attachment process for which it is responsible. The attachment process is according to a protocol defined by the cellular technology used.

The RT module 30 of the node i is able to command its radio transceiver means 32 so as to scan the wireless environment of the node i to discover the AP modules 20 of the neighboring nodes j. At the end of the discovery process, the RT module 30 is capable of generating a list Li of neighboring nodes j of the node i whereof beacon signals have been detected. The list Li in particular includes the connectivity information contained in the message from which the beacon signal is formed.

In the present embodiment, the RT module 30 is able to initiate a discovery process upon receiving a discovery request transmitted by the attachment module 40. Alternatively, the RT module 30 periodically performs this discovery process and provides the attachment module 40 with the list Li.

Upon receiving an attachment request transmitted by the attachment module 40 and which includes the identifier j of a neighboring node, the RT module 30 of the node i is able to initiate an attachment process with that neighboring node j. More particularly, the RT module 30 of the node i is able to carry out the different steps of the attachment method with the AP module of the node j, according to the predefined protocol of the cellular technology used.

The topology module 50 is able to store a current graph Gi showing the component of the network to which the node i belongs at the current moment, called instantaneous connected component. A graph refers to the set of identifiers of the nodes k on the network and attachments between those nodes. A connected component of the node i refers to the set of nodes k with which the node i can exchange a data stream, i.e., there is a network path between the node i and each node k of its instantaneous connected component. The

topology module 50 is part of the routing means of the node i. The manner in which the graph Gi is updated is outside the scope of the present invention.

The stream module 60 of the node i is able to maintain a list Fi of data streams in progress between a source node and a receiving node and that are relayed by the node i. Processing data of the streams are also stored in the list Fi. In particular, a priority associated with each data stream is recorded.

The attachment module 40 is able to generate a message and send it to the AP module 20 such that the latter incorporates it into the beacon signal periodically transmitted. To that end, the attachment module 40 is able to call the topology module 50 to obtain the current graph Gi. The attachment module 40 is then able to determine a piece of connectivity information from the graph Gi.

The message generated by the attachment module 40 incorporates an identifier of the node i and at least one piece of connectivity information. In the present embodiment, this information corresponds to the number ni of nodes present in the connected component of the node i. Alternatively, this connectivity information corresponds to a list gi of identifiers of the nodes present in the connected component of the node i, or to the current graph Gi of the node i, or to other information associated with the connected component of the node.

The attachment module 40 is also able to read the list Li of neighboring nodes j resulting from a discovery request applied to the RT module 30. Among the data contained in that list Li, the attachment module 40 is able to read the connectivity information corresponding to the identifier j of a neighboring node and the number nj of nodes in the connected component of the node j.

The attachment module 40 is able to apply an attachment request to the RT module 30 having, as parameter, the identifier j of the neighboring node selected for an attachment.

The attachment module 40 of the node i is able to select the neighboring node to which it will attach, by implementing an attachment method, such as the method 100 shown in figure 3, which will now be described.

The method 100 includes a first part 110, done in combination with the AP module 20 of the node i.

In a first step 112 of this first part 110, the attachment module 40 calls the topology module 50 so as to obtain the current graph Gi. The attachment module 40 calculates the number ni of nodes that are part of its connected component.

In step 114, the attachment module 40 generates a message containing the identifier of the node i and the value of the number ni calculated in step 112.

In step 116, the attachment module 40 sends the message generated in step 114 to the AP module 20 so that the latter periodically transmits it in the form of a beacon signal.

The method 100 includes a second part 120, done in combination with the RT module 30 of the node i. This second part 120 can be implemented after each performance of the first part 110.

In step 122, the attachment module 40 of the node i commands the RT module 30 so as to scan the wireless environment of the node i.

The RT module 30, after having scanned the wireless environment seeking beacon signals transmitted by j neighboring nodes, sends the attachment module 40 a list Li. The latter includes, for each discovered neighboring node j, the connectivity information transmitted by the AP module of the node j (number nj of nodes present in the connected component of the node j).

In step 122, the attachment module 40 of the node i also queries the topology module 50 and stores the current graph Gi sent in the response received from the topology module 50 (this step is identical to step 112 of the first part 110).

At the beginning of step 124, a variable n of the maximum number of nodes in a connected component is initialized at the value ni. The value ni is the number of nodes present in the graph Gi. In order to determine the value ni, the processing module 40 counts the number of nodes in the graph Gi.

A variable y of the mean length of the paths in the connected component is initialized at the value yi. In order to obtain the value yi, the processing module 40 computes, after applying an algorithm to the graph Gi, such as the Djikstra algorithm known by those skilled in the art, the mean value yi of the length of the paths in the graph Gi.

Variables Id1, Id2 and fi are also initialized at the Zero value.

The process 100 then enters a loop 130 of the "FOR... DO..." type indexed on the identifiers j of the nodes from the list Li.

In step 132, the attachment module 40 verifies whether the neighboring node j is present in the graph Gi.

If the neighboring node j does not belong to the connected component of the node i, in step 134, the attachment module 40 compares the current value of the variable n with the number nj of nodes in the connected component of the node j, indicated in the list Li.

When nj is greater than n, this means that the neighboring node j has more nodes in its connected component than the node i and that it would be appropriate for the node i to attach itself to the neighboring node j in order to increase the size of its connected component.

Then, in step 136, the value nj is assigned to the variable n and, in step 138, the identifier j is assigned to the variable Id1.

At the end of step 138, the method follows the loop 130 to process the next neighboring node in the list Li.

If, in step 134, the number nj is less than or equal to the current value of the number n, the neighboring node j is not selected as a candidate for attachment.

The method follows the loop 130 to process the next node j in the list Li.

If, in step 132, it is observed that the node j belongs to the connected component of the node i, the following processing operation is done.

In step 140, the attachment module 40 determines the mean length yj of each of the paths through its connected component if it was modified such that the node i is attached to the node j. To that end, the attachment module 40 modifies the graph Gi by establishing a link between the node i and the node j and breaking the current link between the node i and the node k to which the node i is currently attached. By computing the mean length of the paths between the pairs of nodes of the modified connected component, the attachment module 40 determines the value of yj.

In step 142, if the mean length yj is greater than or equal to the current value of the variable y, the method 100 follows the loop 130 to process the following node j in the list Li.

If, however, the mean length yj is smaller than the current value of the parameter y, in step 146, the mean length yj is assigned to the variable y, and, in step 148, the identifier j is assigned to the variable Id2.

At the end of step 148, the method follows the loop 130 to process the next node j in the list Li.

Once all of the inputs in the list Li have been processed, the method 100 leaves the loop 130 and continues as follows.

In step 152, it is verified whether the identifier id1 is zero. If it is not zero, that means that a neighboring node j, not belonging to the connected component of the node i, has a greater connected component than that of the node i. In order to increase the size of the connector component of the node i, it is desirable for the node i to attach to the node j and break the current attachment, if the latter exists.

Then, in step 154, the attachment module 40 verifies that the breaking of the current link between the node i and the node k will not have any impact on the communications in progress. To that end, the attachment module 40 queries the stream module 60, which, in response, sends it the list Fi of data streams currently passing through that node i. From that list Fi, the attachment module 40 determines the number fi of data streams in progress (or, alternatively, the number of data streams in progress for each priority level).

In step 156, the attachment module 40 verifies that the number fi computed in step 154 does not exceed a predetermined threshold.

If the threshold is exceeded, the method 100 is interrupted.

If the predetermined threshold is not exceeded, the neighboring node that is a candidate for an attachment is retained and the second part of the method goes on to step 158.

In step 158, the attachment module 40 commands the RT module 30 to break the attachment in progress, when such an attachment exists, and initiates the attachment process with the AP module 20 of the selected node j.

If, in step 152, the identifier Id1 is zero, the attachment module 40 verifies the value of the identifier id2, in step 160.

If id2 is not zero, that means that it is preferable for the node i to be attached to the selected node j so as to minimize the length of the paths in its connected component.

Steps 154 and 156 are carried out to determine whether it is necessary to retain the candidate Id2. In the affirmative, step 158 is carried out to break the attachment in progress, when such an attachment exists, and initiate the attachment process with the AP module 20 of the selected node j.

If, in step 160, the identifier Id2 is zero, the second part 120 of the method 100 is completed.

The method 100 is carried out periodically by the module 40 unless, between two "voluntary" performances, the RT module 30 indicates that the current attachment has been broken and that an attempt should be made to establish a new connection. In that case, as of reception by the attachment module 40 of a message indicating breakage of the current attachment, the second part of the method 100 is carried out.

By implementing the method 100, the attachment module 40 of the node i is able to select, based on connectivity information, a neighboring node to which it is desirable for the node i to be attached and commands the RT module 30 by telling the it identifier of the neighboring node to which it should attach itself.

In figures 4 and 5, graphs 410 and 510 respectively show the percentage of pairs of nodes able to exchange data and the mean length of the paths in an ad hoc mobile network based on wireless cellular technology whereof each node implements the attachment method 100 described above. These graphs result from a digital simulation of the evolution over time of the topology of the network, during movements of the different nodes.

According to this simulation, the implementation of the attachment method 100 makes it possible to obtain a network whereof the graphs are, at all times, close to the graphs 400 and 500 of the optimal network, defined considering that each node i is attached to all of the nodes j present within its radio range (i.e., there is no single attachment constraint).

This is in opposition with graphs 420 and 520, which correspond to a network in which each node implements an attachment method in which the selected node is chosen randomly from among the neighboring nodes.

Many alternatives of the attachment method of figure 3 can be considered. Other criteria may be tested by the attachment module of a node i so as to select that which constitutes the best node in its vicinity in terms of network connectivity. For example, if the computation capacities of a node prove sufficient and if it does not represent an overload on the network, the beacon signal of a node j may contain the list gi of identifiers of the nodes of its connected component, or the complete graph Gi of its connected component. The present attachment method using connectivity information may be incorporated into a more complex attachment method to account for this additional connectivity information.

Of course, traditional criteria, such as the quality of the received beacon signal, can be taken into account in the attachment method.

When a node includes several RT modules, the second part 120 of the attachment method 100 is repeated for each of the RT modules.

In the embodiment previously described, the connectivity information is transmitted using the radio transceiver means, with which the nodes are equipped for implementing the wireless cellular technology. Alternatively, communication means dedicated to exchanging connectivity information are provided: these may involve the simple definition of a specific communication channel in the context of the wireless cellular technology used, another cellular technology, etc.

It should be noted that, in the preceding embodiment, the network is homogenous in that a single wireless cellular technology is used. Alternatively, the network implements several wireless cellular technologies simultaneously.

Additionally, many alternative embodiments of the present attachment method may be considered.

For example, in figure 6, a system 600 has been shown in which each node i of the network includes, in addition to means 22 and 32 making it possible to transmit and receive radio waves in the frequency band allocated to the wireless cellular technology implemented, a transceiver means 42 dedicated to the attachment module 40'. Each node of the network is thus connected to a second network using a specific protocol.

That second network advantageously includes a satellite component. The system then includes a satellite relay station 70, the geographic coverage of which extends over the entire geographic zone within which the nodes i of the network are called upon to move.

The system lastly includes an operational unit 80 including a means making it possible to connect the operational unit to the second network. In figure 6, the operational

unit is equipped with a radio wave transceiver means 82 with the satellite component of the second network.

Thus, a communication may be established, via the satellite relay station 70, between an attachment module 40' at each node i of the network and the operational unit 80.

For each node i, the operational unit 80 is able to implement the attachment method 100. The attachment module 40' then performs only a communication interface function between the operational unit 80 on the one hand, and the AP 20, RT 30, topology 50 and stream 60 modules of the corresponding network, on the other hand.

Thus, the list Li generated by the RT module 30, the graph Gi maintained by the topology module 50 and the list Fi of streams in progress maintained by the stream module 60 are sent by the attachment module 40' to the operational unit 80.

From that connectivity information, the operational unit 80 selects the node j to which the node i must attach.

Once the neighboring node j has been selected, the identifier j of that node is transmitted from the operational unit 80 to the attachment module 40' of the node i.

The attachment module 40' then commands the RT module 30 to break the attachment in progress (if one exists) and initiate the attachment process with the selected neighboring node j.

In that system, many alternatives of the selection method can then be considered.

In one alternative, the operational unit 80 has each of the graphs Gj of the nodes of the network, obtained during the performance of the step of the selection method corresponding to step 122, at each node j.

It is then no longer necessary for the attachment module 40' j of a node to generate a message including connectivity information other than the identifier of the node j.

Thus, when the node i informs the operational unit 80 that it has detected the beacon signal of the node j, the operational unit 80 carries out the attachment method using the graph Gj of the connected component of the node j, which the latter has already sent to the operational unit 80.

In another alternative independent of the previous one, after a first performance of the attachment method for the node i, and a first performance of the node j, the operational unit performs the attachment method a second time for the node i. The selection method is thus repeated several times for one or more node(s) (from the same connectivity information), until a convergence occurs toward a topology of the network in which there is no longer any modification of the attachments between nodes.

In still another alternative, the operational unit implements an attachment method using overall criteria using the connectivity information collected from the nodes. These

criteria for example consist of maximizing a cost function related to the connectivity of the network and the variables of which are, *inter alia*, the connectivity information. Thus, although the attachment of a node i to a node j, the number nj of which is below the number ni, is not locally deemed interesting for the node i, the operational unit may request that attachment and simultaneously request the attachment of a node k of the connected component of the node j with a node l of the connector component of the node i, in order to globally achieve a maximal connectivity of the network.

The present attachment method is advantageously implemented to form an ad hoc network using LTE ship-to-ship technology. The AP module is an eNode B (evolved Node B) and the RT module is a piece of user equipment UE. The LTE technology may have a range of 10 nautical knots by using transceiver means including a directive antenna, for example of the FESA™ (Fast Electronically Sterile Antenna) type, or of the sectoral type.

The ad hoc network between ships may optionally connect with nodes located on the coast (ship-to-shore) using the same technology.

The present attachment method is advantageously implemented to form an ad hoc network deployable between vehicles. Each vehicle is equipped with a telescoping mast, for example 18 m tall, so as to build a deployable LTE infrastructure. The network can then provide connectivity to pedestrians equipped with LTE terminals or aircraft, such as helicopters.

CLAIMS

1.- An attachment method (100) in an ad hoc mobile network based on wireless cellular technology, of the type including a plurality of nodes (i), each node including an access point module (20), at least one relay terminal module (30), a relay terminal module of one node being able to discover the access point module of neighboring nodes and initiate an attachment process with an access point module of a selected neighboring node, a relay terminal module of one node being attached at most to an access point module of a neighboring node,
characterized in that it includes a step consisting of selecting a neighboring node (j) to which a considered node must initiate an attachment process among the nodes from a list (Li) resulting from a discovery step, carried out by the relay terminal module (30) of the considered node, and based on at least a piece of connectivity information relative to the connected component of the considered node and at least a piece of connectivity information relative to the connected component of each neighboring node of the list.

2.- The method according to claim 1, characterized in that said at least one piece of connectivity information of a node is chosen from among a number (ni) of nodes present in the connected component of the node, a list (gi) of identifiers of the nodes present in the connected component of the node, and a graph (Gi) of the connected component of the node.

3.- The method according to claim 1 or claim 2, characterized in that, each node having a topology module (50) storing a graph (Gi) of the connected component of the node (i), the method includes a step (122) for querying the topology module in order to obtain the current graph (Gi) of the connected component of the node (i), a step for computing said at least one piece of connectivity information and a step for transmitting the or each computed piece of connectivity information.

4.- The method according to claim 3, characterized in that the transmission step consists of transmitting (116), via the access point module of said node, a beacon signal including the or each piece of connectivity information (i, ni, gi, Gi), and in that the method includes, during the discovery step by the relay terminal module of the considered node, a step for collecting the or each piece of connectivity information of a neighboring node (j) whereof a beacon signal has been detected by said considered node.

5.- The method according to any one of claims 1 to 4, wherein the step consisting of selecting a neighboring node includes a step (132) for verifying that the neighboring node (j) does not belong to the connected component of the considered node (i) and, in the affirmative, a step (134) for comparing the number (nj) of nodes present in the connected component of the neighboring node (j) with the number (ni) of nodes present in the connected component of the considered node (i), the neighboring node being selected when the number of nodes in its connected component is greater than that of the connected component of the considered node.

6.- The method according to claim 5, including, in the step consisting of selecting a neighboring node includes a step for verifying (132) that the neighboring node (j) does not belong to the connected component of the considered node (i) and, in the negative, a step for comparing (142), on the one hand, the mean length (yi) of the paths between the connected component of the considered node (i) and, on the other hand, the mean length (yj) of the paths without the connected component of the considered node, modified such that the considered node is attached to the neighboring node, the neighboring node being selected when the mean length of the paths in the connected component of the modified considered node is smaller than the mean length (yi) of the paths in the connected component of the considered node (i).

7.- The method according to any one of claims 1 to 6, wherein, each node including a stream module (60) maintaining a list (Fi) of the data streams relative to the communications in progress relayed by said receiving node (i), the method includes, before a step consisting of commanding the relay terminal module of the considered node (i) to initiate an attachment process to the access point module of the selected neighboring node (j), a step consisting of querying the stream module in order to obtain the list of streams in progress, determine the number (fi) of data streams in progress and verify that the number (fi) of streams in progress is below a predetermined threshold.

8.- The method according to any one of claims 1 to 7, wherein the selection step is carried out at a central operational unit, in communication with each of the nodes of the network and able to transmit, to a considered receiving node, the identifier of the selected neighboring node to which it must connect.

9.- The method according to any one of claims 1 to 7, wherein the selection step is carried out at each node.

10.- An information recording medium, characterized in that it includes the instructions for implementing attachment method according to any one of claims 1 to 9, when those instructions are executed by a computer.

11.- A system including a plurality of nodes (i), each node including an access point module, a relay terminal module of a node being able to discover the access point module of the neighboring nodes and initiate an attachment process with an access point module of a selected neighboring node, a relay terminal module of a node being attached to at least one access point module of a neighboring node,
characterized in that it is able to carry out an attachment method according to the method according to any one of claims 1 to 9, the system including a selection means capable of selecting a neighboring node to which a considered receiving node must initiate an attachment process among the nodes from a list resulting from a discovery step, by the relay terminal module of the receiving node, and considering at least one piece of connectivity information relative to the connected component of the considered node and one piece of connectivity information relative to the connected component of the neighboring nodes mentioned in the list.

12.- The system according to claim 11, wherein the access point module of one node is able to send at least one piece of connectivity information relative to its connected component using a wireless transceiver means of the AP module or using a transceiver means of a radio technology other than that implemented for the ad hoc network.

13.- A node including an access point module and at least one relay terminal module, the relay terminal module of the node being able to discover access point modules of neighboring nodes and initiate an attachment process with a module of an access point of a selected neighboring node, the relay terminal module of the node being attached at most to one access point module of a neighboring node, characterized in that it can be part of the system according to claim 11 or claim 12.