

Method for managing a communication network and associated communication network

The present invention relates to a method for managing a communication network.

5 The present invention also relates to a communication network.

In the military field, when vehicles are deployed, the vehicles communicate via radio transmissions, all of the vehicles forming a network.

However, the mission imperatives combined with the nature of the terrain (in particular presence of relief) may cause some vehicles to be isolated from others in terms
10 of radio communications (out of range). This is problematic if, when these vehicles are out of range, a change of configuration of the entire network takes place, since the vehicles can no longer be re-integrated into the network even when these vehicles return within radio range. The vehicles are therefore not only isolated for the rest of the mission, but additionally risk generating interference toward vehicles in the same network, which would
15 have been within radio range at the time of the reconfiguration request. This interference may compromise the proper progression of the mission.

To avoid this problem, one approach consists of not reconfiguring the network during a mission.

Such an approach makes the mission less adaptable based on unforeseen issues.

20 It is also known to modify an Automatic Identification System (AIS). The AIS is a maritime radio system for the positioning and identification of ships, land-based stations, real and virtual buoys for separating maritime traffic and rescue airplanes on search and rescue missions. The modification of the AIS consists of self-regulation of the access to a resource by managing the contention via a prior listening and repetition sequence.

25 Nevertheless, such an AIS allows a split and merging of subnetworks, but does not make it possible to provide a service with guaranteed bandwidth of the voice transmission or video type; it remains solely applicable to an identification service with few latency constraints and low bandwidth.

There is therefore a need for a method for managing a mobile and mesh
30 communication network that is more flexible and easily dynamically adaptable, capable of splitting into subnetworks based on elongation constraints, and the subnetworks of which are able to merge again once the radio connectivity between subnetworks is reestablished.

To that end, the present description relates to a method for managing a
35 communication network, the communication network comprising a set of mobile nodes and at least one central station, the central station including a controller and a transceiver

chain, each node including a satellite antenna adapted to receive radio signals, the communication network being characterized by at least one configuration determining the operation of the communication network, the set of nodes including reception nodes and satellite nodes,

5 wherein the satellite nodes are configured to transmit satellite signals to a satellite, and wherein the reception nodes lack an antenna configured to emit signals to the satellite,

the method for managing comprising the following steps:

- reception by the controller from the satellite nodes of at least one reconfiguration need of the communication network,
- 10 - determination of a configuration of the communication network by the controller based on a synthesis of the reconfiguration needs expressed during a given time interval,
- generation of a reconfiguration message of the communication network to transmit the configuration determined in the determining step to each node,
- 15 - emission by the transceiver chain of the reconfiguration message to each node via the satellite,
- reception by the satellite antenna of the reconfiguration message, and
- for each node, moving to the determined configuration by commanding the node so that the node conforms to the new configuration of the network by applying configuration setpoints contained in the configuration message to a transceiver device of said node.
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According to specific embodiments, the method comprises one or more of the following features, considered alone or according to any technically possible combinations:

- the reconfiguration message is sent to a modem adapted to perform transmissions by spread spectrum over a width greater than 1 MHz, in particular obtained by a direct sequence spread spectrum technique;
- the satellite antenna is an antenna not pointed on the satellite and adapted to receive a transmission by spread spectrum coming from a multitude of directions;
- 30 - the central station is fixed;
- the reconfiguration message includes a datum relative to an application time of the determined configuration;

- the moving step is only carried out if the application time is less than or equal to the local time;

5 - when a node does not receive the signals coming from the transceiver chain, the method includes a step for warning at least one other node of the fact that said node does not receive the signals coming from the transceiver chain and a step for resending the reconfiguration message from the warned node to said node not receiving the signals coming from the transceiver chain;

10 - the configuration includes at least one of the following commands:

- a change in the distribution into subgroups of the set of nodes, and
- a change of at least one communication channel allocated for a communication between the nodes of the communication network;
- at least one need depends on the quantity of data to be transmitted between at least two nodes, the distance between two nodes or the number of nodes communicating with one another;
- each receiving node lacks an antenna configured to emit signals to the satellite;
- each satellite node is equipped with an antenna configured to emit signals to the satellite;
- the determined configuration is a configuration of all network elements;
- the determined configuration applies to all nodes of the communication network;
- the determined configuration is independent of a status or the presence or not of a node of all nodes.

The present description also relates to a communication network comprising a set of mobile nodes and at least one central station, the central station including a controller and a transceiver chain, each node including a satellite antenna adapted to receive radio signals, the set of nodes including reception nodes and satellite nodes, each satellite node including a satellite antenna able to send and receive radio signals, the satellite nodes being configured to transmit satellite signals to a satellite, and the reception nodes lacking an antenna configured to emit signals to the satellite, the communication network being characterized by a configuration determining the operation of the communication network, the controller being able to obtain at least one reconfiguration need of the communication network of the satellite nodes, determine a configuration of the communication network based on a synthesis of the reconfiguration needs expressed during a given time interval, and generate a reconfiguration message of the communication network to pass the determined configuration to each node, the transceiver chain being able to transmit the reconfiguration message to each node via the satellite, each satellite antenna able to receive the reconfiguration message, each node being able to switch to the determined configuration by commanding the node so that the node conforms to the new configuration of the network by applying configuration setpoints contained in the configuration message to a transceiver device of said node.

Other features and advantages of the invention will appear upon reading the following description of embodiments of the invention, provided solely as an example and done in reference to the drawings, which are:

- figure 1, a schematic illustration of a communication system comprising a plurality of nodes, and
 - figure 2, a detailed schematic illustration of the communication system of figure 1.
- A communication system 11 is illustrated schematically in figure 1.

The system 11 comprises a communication network 12 and a communication network 13.

5 The communication network 12 comprises a set of nodes 18 comprising reception nodes 18A and satellite nodes 18B. The nodes 18B are simultaneously present on the network 12 and the network 13.

The network 12 is a radio network, i.e., a network 12 whereof the communications between the nodes 18A or 18B are radio communications.

10 According to the described example, the network 12 is a UHF network. A UHF network is a network using ultra-high-frequency waves, i.e., waves corresponding to a band of the radiofrequency spectrum between 300 Megahertz (MHz) and 3000 MHz.

Alternatively, the network 12 is a VHF network. A VHF network is a network using very high-frequency waves, i.e., waves corresponding to a band of the radiofrequency spectrum between 30 MHz and 300 MHz.

15 In general, the network 12 is a network interconnecting VHF transmissions and UHF transmissions.

The network 12 is characterized by at least one configuration determining the operation of the network 12.

The operation of the network 12 determines the possible radio links between the different nodes 18 as well as the nature of the possible radio links.

20 The nature of the radio links is for example a fixed number of transmission channels, a fixed transmission timeslot, a fixed carrier frequency, a fixed transmission frequency or a fixed frequency bandwidth.

In particular, the operation of the network 12 determines subgroups of nodes 18 and their communication modes via a radio link.

25 The network 13 comprises both the nodes 18B and a central station 14. The network 13 is a satellite network, i.e., the nodes 18B are able to communicate by satellite transmission to the central station 14.

According to the illustrated example, the central station 14 is fixed.

30 This means that the central station 14 has a geographical position that does not vary over time.

The central station 14 includes communication elements to provide satellite communications with the satellite nodes 18B, which are therefore both present in the satellite network 13 and in the radio communication network 12.

A satellite 16 is further illustrated schematically in figure 1.

35 The satellite 16 comprises, not shown, a satellite signal receiver and transmitter.

Satellite signals refer to radio signals received by the satellite 16 or sent by the satellite 16.

The satellite 16 is for example a geostationary satellite or constellation of satellites in a low Earth orbit.

5 The satellite 16 is configured to receive satellite signals from a satellite communication zone 19 and to broadcast the satellite signals in the satellite communication zone 19.

As shown in figure 2, the central station 14 further comprises a central controller 20 and a central transceiver chain 22.

10 The central controller 20 is a computer.

More generally, the central controller 20 is an electronic logic controller able to manipulate and/or transform data represented as electronic or physical quantities in registers of the central controller 20 and/or memories into other similar data corresponding to physical data in the memories or registers.

15 The central controller 20 is able to control all of the elements belonging to the central station 14.

In particular, the central controller 20 is able to determine a configuration of the network 12 based on the reconfiguration need(s) of the network 12 escalated by the satellite nodes 18B.

20 "Reconfiguration need of the communication network" refers to a service requirement to be provided for the network 12, and in particular for certain nodes 18.

As an illustration, the reconfiguration need of the network 12 depends on a quantity of data to be transmitted between at least two nodes 18, the distance between two nodes 18 or the number of nodes 18 communicating with one another.

25 The quantity of data to be transmitted in particular depends on the type of data to be transmitted. For example, a video to be transmitted requires more data than a voice signal.

The distance between two nodes 18 determines the power of the signal to be transmitted so that the two nodes 18 can communicate with one another.

30 The number of nodes 18 communicating with one another corresponds to the distribution of the nodes into subgroups.

When the determined configuration is different from the current configuration of the network 12, the central controller 20 is able to request a reconfiguration of the network 12. "Reconfiguration" refers to a change of the configuration of the network 12.

35 The reconfiguration for example includes one or several commands, such as a change to the distribution into subgroups of the set of nodes 18 and/or a change of at

least one communication channel allocated for a communication between the nodes 18 of the network 12.

The central controller 20 is connected to the central transceiver chain 22.

5 The central transceiver chain 22 includes a central converter 24 and a central antenna 26.

The central converter 24 is able to convert the reconfiguration request from the central controller 20 into a reconfiguration message to be sent to the nodes 18.

The central converter 24 includes a central conformation module 27 and a central band transposition module 28.

10 The central molding module 27 is able to conform a digital signal into a radio signal having a waveform with a spread of the spectrum greater than 1 MHz.

The central conformation module 27 is for example a modem capable of performing spread spectrum transmissions over a width greater than 1 MHz.

15 The spread is for example obtained through a direct sequence spread spectrum (DSSS) technique. During the spreading, the digital signal is combined with a pseudorandom signal, forming a spread signal. The spread signal occupies a wider frequency band, determined by the frequency of the pseudorandom signal.

20 The central transposition module 28 is able to convert a signal in a first frequency band into a second frequency band, the second frequency band being different from the first frequency band.

The first frequency band belongs, in the described example, to the radiofrequency domain.

The second frequency band is a frequency band allowing satellite transmission.

25 For example, the second frequency band is the X band. The X band is a frequency band between 8 gigahertz (GHz) and 12 GHz.

According to the described example, the second frequency band is the Ku band. The Ku band is a frequency band between 12 GHz and 18 GHz.

The central transposition module 28 thus makes it possible to obtain the reconfiguration message to be sent.

30 The central antenna 26 is preferably a directional antenna.

"Directional antenna" refers to an antenna configured to transmit a signal having a high power in a particular direction. In other directions, the power of the signal is lower relative to the high power.

35 The central antenna 26 is for example a parabolic antenna. The parabolic antenna comprises a parabolic mirror and a transceiver unit arranged at a focal point of the parabolic mirror.

The central antenna 26 is able to transmit the reconfiguration message in the Ku band to a satellite 16.

5 The nodes 18 are mobile. By definition, a mobile node 18 has a geographical position that may vary over time and an orientation relative to the satellite that also evolves.

A node 18 is now described in reference to figure 2, each node 18 including the same elements.

The central station 18 includes communication elements to provide radio communications with the other nodes 18 or the central station 14.

10 The node 18 comprises a local reception chain 30, a local controller 32 and a transceiver device 33.

The local reception chain 30 comprises a local satellite antenna 34 and a local converter 36.

The local satellite antenna 34 is for example a hemispherical antenna.

15 "Hemispherical antenna" means an antenna that is able to receive or send signals in half of the space. In the example, the local satellite antenna 34 is able to receive or transmit signals in the hemisphere oriented upward, relative to a horizontal plane.

The local satellite antenna 34 for example forms a disc having a circular edge in a plane.

20 The satellite antenna 34 is for example an antenna not pointed on the satellite 16. The satellite antenna 34 is capable of receiving a transmission by spread spectrum coming from a multitude of directions.

The local satellite antenna 34 is able to receive the reconfiguration message in the Ku band coming from the satellite 16.

25 For example, the central antenna 26 is of a different type from the local satellite antenna 34. In one example, the central antenna 26 is a parabolic antenna and the local satellite antenna 34 is a hemispherical antenna.

The local converter 36 includes a local band transposition module 38 and a local conformation module 40.

30 Like for the central band transposition module, the local band transposition module 38 is able to convert a signal in a first frequency band into a second frequency band, the second frequency band being different from the first frequency band.

In the illustrated example, the local band transposition module 38 is able to convert the received reconfiguration message into a radiofrequency signal.

35 The local conformation module 40 is able to convert the radiofrequency signal into a digital signal able to be exploited by the local controller 32.

The local controller 32 is able to determine a reconfiguration command contained in the reconfiguration message.

The local controller 32 is a computer.

5 More generally, the local controller 32 is an electronic logic controller able to manipulate and/or transform data represented as electronic or physical quantities in registers of the local controller 32 and/or memories into other similar data corresponding to physical data in the memories or registers.

The transceiver device 33 is a land-based transceiver device.

10 "Land-based transceiver device" means a device capable of transmitting or receiving communication signals belonging to the radiofrequency domain.

The communication signals are for example UHF links of the UHF network.

The communication signals are signals transferred directly between two transceiver devices 33, without going through a satellite.

15 In the example of figure 1, the nodes 18 are distributed into three subgroups 50, 52 and 54. Each subgroup 50, 52 and 54 for example corresponds to a respective and specific mission.

Each node 18 of a subgroup 50, 52 and 54 is able to transmit the communication signals to the other nodes 18 of the same subgroup 50, 52 and 54 and to receive the communication signals from the nodes 18 of the same subgroup 50, 52 and 54.

20 The nodes 18 of the subgroups 50, 52, 54 are further configured to receive the satellite signals transmitted by the satellite 16 (symbolized by the flash 56 in figure 1).

The nodes 18B of the subgroup 50 are further configured to transmit satellite signals to the satellite 16 (symbolized by the flashes 58 in figure 1).

25 It is noted that in the example in Figure 1, each 18A receiving node lacks an antenna configured to emit signals to satellite 16.

In particular, only each node in subgroup 50 is configured to emit signals to satellite 16. These nodes in subgroup 50 are satellite nodes 18B. This implies that each satellite node 18B is equipped with an antenna configured to emit signals to satellite 16.

30 On the contrary, the nodes of subgroups 52 and 54, known as reception nodes 18A, do not have a transmission capacity to satellite 16. Indeed, the 18A receiving nodes do not include an antenna configured to emit signals to satellite 16.

35 It should be noted that the central controller 20 is suitable for determining the configuration, called the determined configuration. The determined configuration is a configuration of the communication network 12, i. e. a configuration of all the elements of the network 12.

As described above, the determined configuration is a configuration of the communication network 12. The determined configuration applies in particular to all nodes 18 of the communication network 12.

5 In particular, the determined configuration is independent of a status or the presence or absence of a node of all nodes 18.

In particular, this implies that the determined configuration is a data distinct from a status of a particular node of the communication network 12.

Similarly, the determined configuration is distinct from a number of nodes 18 present in the communication network 12.

10 The operation of the network 12 is now described in reference to an example embodiment of the method for managing the network 12 during a reconfiguration maneuver of the network 12.

The method includes a need reception step, a determining step, a generating step, a transmission step, a reception step and a moving step.

15 During the reconfiguration need reception step, the central controller 20 obtains at least one reconfiguration need of the network 12 (symbolized by a flash 60 in figure 2).

To that end, as an example, the central controller 20 collects the needs transmitted by each satellite node 18B.

20 For example, at least one satellite node 18B transmits reconfiguration needs to the satellite 16, which sends the reconfiguration needs to the central controller 20.

The central controller 20 determines, during the determining step, a configuration of the network 12 based on a synthesis of the reconfiguration needs expressed during a given time interval.

25 The synthesis of the reconfiguration needs for example comprises mandatory reconfiguration parameters, and optional reconfiguration parameters.

More specifically, the central controller 20 looks for a configuration of the network 12 making it possible to meet each reconfiguration need.

30 In practice, because the reconfiguration needs are sometimes contradictory and thus impossible to meet, the central controller 20 looks for a configuration of the network 12 meeting a large number of reconfiguration needs, or at least the highest priority needs.

To carry out such a search, the central controller 20 for example uses a table associating, with a single need, configurations of the network 12 meeting the need.

The determined configuration corresponds to a configuration deduced from the configurations given by the table.

35 The central controller 20 further determines the application time of the configuration.

At the end of the determination step, a new configuration of the network 12 and the time at which to apply it are obtained.

During the generating step, a reconfiguration message is generated allowing each node 18 of the network 12 to be switched to the configuration determined during the determining step.

More specifically, the central controller 20 generates a digital signal to request the reconfiguration.

In the case at hand, the digital signal includes the new configuration of the network 12 and the application time of the new configuration.

The central converter 24 converts the digital signal into a reconfiguration message in the Ku band.

The conversion is done first using the DSSS technique implemented by the central conformation module 27, then by transposition in the Ku band by the central band transposition module 28.

At the end of the generating step, the reconfiguration message to be transmitted is thus obtained.

During the transmission step, the reconfiguration message is transmitted from the central station 14 to each node 18 via the satellite 16.

It is the central antenna 26 that transmits the reconfiguration message.

In the reception step, the reconfiguration message is received by each local satellite antenna 34.

Then, the reconfiguration message is converted by the local converter 36 to obtain a digital signal able to be exploited by the local controller 32.

During the moving step, the local controller 32 then commands the node 18 so that the node 18 conforms to the new configuration of the network 12, in particular by applying configuration setpoints contained in the configuration message to the transceiver device 33.

The local controller 32 sends a command signal via the datalink 62 to the transceiver device 33.

Preferably, the moving step is only carried out if the application time is less than or equal to the local time. In this example, the local controller 32 sends the command signal to the transceiver device if the application time is less than or equal to the local time.

The method for managing allows an easy reconfiguration of the network 12.

In fact, the method for managing allows a reconfiguration of all of the nodes 18 of the network 12 even when the network 12 is split because some nodes 18 are outside radio range. Indeed, via the satellite link, the nodes 18 outside radio range will receive the

reconfiguration message and be able to apply it. Thus, when the nodes 18 are again within radio range, the nodes 18 are synchronized with the others due to the fact that their radio configuration is the same.

5 The method for managing thus allows reconfiguration of the network 12 in near-real time.

It should also be noted that the establishment of such a method for managing on an existing network 12 is relatively easy, since it suffices to add a relatively broadband satellite communication element, which has a smaller size and is inexpensive to install on a node 18.

10 Furthermore, the method for managing is compatible with any type of central station 14 and nodes 18. For example, the method for managing is applicable on a network of fixed stations, fixed or moving vehicles, a network of boats, a network of aircraft or a network integrating all of these means.

15 The method for managing is further robust because the transmitted signal is a narrowband signal (typically less than 1 kb/s) but is transmitted over a relatively broad band (typically more than 1 MHz), such that the spreading factor is significant (typically 30 dB). This spreading factor makes it possible to compensate the low gain of hemispherical antennas relative to the gain of parabolic antennas.

20 Furthermore, this factor makes it possible to proceed with the rejection of interference coming from other satellites.

The method makes it possible to guarantee good reception of the signal received by the largest possible number of nodes 18.

To increase this effect, the transmission step can be carried out several times.

25 For example, the transmission step is carried out periodically, for example every ten minutes.

Furthermore, in case of failure of a node 18, the method for managing comprises additional steps.

The method thus includes additional warning and resending steps.

30 During the warning step, a first node 18 not receiving the reconfiguration steps warns at least one other node 18 (typically the closest node), called second node 18, that the first node 18 is not receiving the reconfiguration signals from the central station 14.

Then, during the resending step, the second node 18 that received the warning resends the reconfiguration message to the first node 18.

35 This robustness makes it possible to carry out the method for managing as many times as desired.

The method for managing further makes it possible to consider other applications. For example, the method for managing may prohibit the transmission of radio communication signals between the nodes 18 by satellite.

CLAIMS

1.- A method for managing a communication network, the communication network comprising a set of mobile nodes and at least one central station, the central station including a controller and a transceiver chain, each node including a satellite antenna adapted to of receive radio signals, the communication network being characterized by at least one configuration determining the operation of the communication network, the set of nodes including reception nodes and satellite nodes,

wherein the satellite nodes are configured to transmit satellite signals to a satellite, and wherein the reception nodes lack an antenna configured to emit signals to the satellite,

the method for managing comprising the following steps:

- reception by the controller from the satellite nodes of at least one reconfiguration need of the communication network,
- determination of a configuration of the communication network by the controller based on a synthesis of the reconfiguration needs expressed during a given time interval,
- generation of a reconfiguration message of the communication network to transmit the configuration determined in the determining step to each node,
- emission by the transceiver chain of the reconfiguration message to each node via the satellite,
- reception by the satellite antenna of the reconfiguration message, and
- for each node, moving to the determined configuration by commanding the node so that the node conforms to the new configuration of the network by applying configuration setpoints contained in the configuration message to a transceiver device of said node.

2.- The method according to claim 1, wherein the reconfiguration message is sent to a modem adapted to perform transmissions by spread spectrum over a width greater than 1 MHz, in particular obtained by a direct sequence spread spectrum technique.

3.- The method according to claim 1 or 2, wherein the satellite antenna is an antenna not pointed on the satellite and adapted to receive a transmission by spread spectrum, the transmission being received from a multitude of directions.

4.- The method according to any one of claims 1 to 3, wherein the central station is fixed.

5.- The method according to any one of claims 1 to 4, wherein the reconfiguration message includes a data relative to an application time of the determined configuration.

5 6.- The method according to claim 5, wherein the moving step is only carried out if the application time is less than or equal to the local time.

7.- The method according to any one of claims 1 to 6, wherein, when a node does not receive the signals coming from the transceiver chain, the method includes a step for warning at least one other node of the fact that said node does not receive the signals coming from the transceiver chain and a step for resending the reconfiguration message from the warned node to said node not receiving the signals coming from the transceiver chain.

8.- The method according to any one of claims 1 to 7, wherein the configuration includes at least one of the following commands:

- a change in the distribution into subgroups of the set of nodes, and
- a change of at least one communication channel allocated for a communication between the nodes of the communication network.

9.- The method according to any one of claims 1 to 8, wherein at least one need depends on the quantity of data to be transmitted between at least two nodes, the distance between two nodes or the number of nodes communicating with one another.

10.- A communication network comprising a set of mobile nodes and at least one central station, the central station including a controller and a transceiver chain, each node including a satellite antenna adapted to receive radio signals, the set of nodes including reception nodes and satellite nodes, each satellite node including a satellite antenna able to send and receive radio signals, the satellite nodes being configured to transmit satellite signals to a satellite, and the reception nodes lacking an antenna configured to emit signals to the satellite, the communication network being characterized by a configuration determining the operation of the communication network, the controller being able to obtain at least one reconfiguration need of the communication network of the satellite nodes, determine a configuration of the communication network based on a synthesis of the reconfiguration needs expressed during a given time interval, and generate a reconfiguration message of the communication network to pass the determined configuration to each node, the transceiver chain being able to emit the

reconfiguration message to each node via the satellite, each satellite antenna able to receive the reconfiguration message, each node being able to switch to the determined configuration by commanding the node so that the node conforms to the new configuration of the network by applying configuration setpoints contained in the configuration message to a transceiver device of said node.