A method for integrating network subscribers into an ad-hoc network and an associated ad-hoc network

The invention relates to a method for integrating network subscribers into a time-synchronised ad-hoc network and an associated ad-hoc network.

Modern radio networks are realised as mobile ad-hoc networks. Ad-hoc networks do not provide an infrastructure for the transmission of voice and data traffic between the individual network subscribers. Instead, the individual network subscribers of an ad-hoc network organise the respective transmission of voice and data traffic themselves.

One quite substantial task in the organisation and operation of an ad-hoc network is the time synchronisation of the individual network subscribers. In this context, a frequency-hop method is used in order to prevent any disturbance of the transmission traffic. Accordingly, the carrier frequency of the transmission is modified within a given time course according to a given frequency pattern. The frequency pattern of the carrier frequency against time is known to the individual network subscribers of an ad-hoc network. To ensure that all network subscribers of an ad-hoc network switch over from one carrier frequency to the next carrier frequency of the frequency pattern at the same time, they require an identical reference time. For this purpose, a time synchronisation between all of the network subscribers of the ad-hoc network is implemented within a given time grid.

A device and a method for time synchronisation between the network subscribers of an ad-hoc network are known from WO 2011/154911 A1. In this context, the entire ad-hoc network is

subdivided into individual groupings - so-called clusters - comprising regionally adjacent network subscribers which are positioned within the mutual transmission and/or reception range. In this case, both the transmission of payload data and also the time synchronisation within a cluster are implemented through an individual transmission process (a so-called one-hop transmission). Alongside this intra-time-synchronisation within the individual clusters, a time synchronisation within the overall ad-hoc network is implemented via an inter-time-synchronisation between respectively adjacent clusters.

In order to minimise or prevent any disturbance of the time synchronisation, the continual time synchronisation within one cluster is implemented in each case by alternating network subscribers of a cluster which are positioned in the transmission and/or reception range of all of the other network subscribers of the cluster. Accordingly, a typically encoded synchronisation bit pattern known to all of the network subscribers of the ad-hoc network is transmitted to the other network subscribers of the cluster. The other network subscribers of the cluster accordingly synchronise their internal reference time with the internal reference time of the network subscriber transmitting the synchronisation bit pattern by comparing the reception time of the synchronisation bit pattern measured at their previous internal reference time, the time since the common activation of all network subscribers of the cluster measured at their previous internal reference time and the transmission time of the synchronisation bit pattern stored in the synchronisation bit pattern and measured at the internal reference time of the transmitting network subscriber.

In mobile ad-hoc networks, the positions of the individual network subscribers change constantly. Accordingly, for every

network subscriber, the respective, regionally adjacent network subscribers of the mobile ad-hoc network, especially of the regionally adjacent network subscribers within the cluster, change over time. For this reason, the communication of the voice and/or data transmission - so-called routing - between the transmitting network subscriber and the associated receiving network subscriber in an ad-hoc network must not only be continually matched, but the composition of the cluster comprising constantly changing network subscribers and the time synchronisation between the constantly changing network subscribers within a cluster must also be continually matched.

The object of the invention is therefore to provide a method for integrating new network subscribers into existing time-synchronised clusters of a mobile ad-hoc network and to provide the time synchronisation of the network subscriber integrated into the cluster with the other network subscribers of the cluster and to provide a correspondingly designed mobile ad-hoc network.

This object is achieved by a method according to the invention for integrating network subscribers into a time-synchronised ad-hoc network with the features of claim 1 and by an ad-hoc network according to the invention with the features of claim 16. Advantageous technical developments are specified in the respectively dependent claims.

Since the organisation of the operation of a cluster, especially for the time synchronisation within a cluster, the case of removing a network subscriber from the cluster is unproblematic by comparison with the case of integrating a network subscriber into a cluster, only the case of

integrating a network subscriber into a cluster will be considered in the following section.

On the basis of the clusters formed in a mobile ad-hoc network from respectively regionally adjacent network subscribers and the time synchronisation of all network subscribers in each cluster, one network subscriber selected in each cluster, which is positioned at the periphery of the respective cluster, determines the network subscribers to be integrated into the respective cluster. By selecting a network subscriber at the periphery of the respective cluster, it is possible to identify the maximum number of potential network subscribers to be integrated into the respective cluster. The network subscribers identified for integration are then time-synchronised with the network subscribers of the respective cluster.

An identification of network subscribers to be integrated into the respective cluster is preferably repeated within a given time intervals, whereas a different network subscriber of the respective cluster is preferably selected for identification in each case.

Additionally, the network subscribers implementing the identification of network subscribers to be integrated into the respective cluster should preferably be selected in such a manner that they are disposed maximally within the transmission and/or reception range of a previously specified number of network subscribers which belong to a cluster time-synchronised with the ad-hoc network, and respectively that, in the ideal case, they are not disposed in the transmission and/or reception range of any network subscriber which belongs to a cluster time-synchronised with the ad-hoc network. Otherwise, it must be anticipated with a high degree of

probability that all of the network subscribers disposed in the transmission and/or reception range of the selected network subscriber are already integrated in a cluster time-synchronised with the ad-hoc network, and accordingly, for the selected network subscriber, the identification of a network subscriber to be integrated into its own cluster is improbable. The knowledge required for this purpose regarding the network subscribers disposed in the immediate regional proximity of a network subscriber of a mobile ad-hoc network is constantly updated with a proactive routing method.

On the one hand, to prevent the transmission efficiency in a mobile ad-hoc network from being unnecessarily impaired by the time synchronisation and, on the other hand, as far as possible, to prevent the time synchronisation from being disturbed by a third party, the time synchronisation is preferably implemented within individual, first time intervals, which each provide a constant, minimum possible duration and are spaced from one another with a statistically fluctuating time spacing.

The time synchronisation within a cluster is preferably implemented by a network subscriber of the cluster which is positioned in the transmission and reception range of all of the other network subscribers, in order to achieve availability and therefore a common time synchronisation of all network subscribers of the respective cluster. For the time synchronisation, the network subscriber transmits information for the time synchronisation in a first time interval which is known to all of the network subscribers of the ad-hoc network.

To avoid any unnecessary impairment of the transmission efficiency in the ad-hoc network, the time synchronisation

within a cluster of network subscribers is preferably suspended so long as the number of network subscribers within the respective cluster does not change.

In a first preferred embodiment of the invention, the network subscriber selected in the respective cluster identifies an individual network subscriber which is positioned in the transmission and/or reception range of the selected network subscriber and intends to join the ad-hoc network.

In a second preferred embodiment of the invention, the selected network subscriber in the respective cluster identifies an entire cluster of mutually time-synchronised network subscribers which intends to join the ad-hoc network, and which provides a network subscriber within the transmission and/or reception range of the selected network subscriber of the cluster time-synchronised with the ad-hoc network.

In a first preferred variant of the invention, which can be realised both in the first embodiment and also in the second embodiment of the invention, the search for an individual network subscriber or for a cluster of network subscribers time-synchronised with one another, which intend/s to join the cluster time-synchronised with the ad-hoc network is implemented by the selected network subscriber of the respective cluster time-synchronised with the ad-hoc network.

For this purpose, the selected network subscriber in the first embodiment of the invention transmits information searching for a network subscriber to be integrated. The identification of the network subscriber to be integrated in the respective cluster time-synchronised with the ad-hoc network is completed with the reception of the acknowledgement of the information

searching for a network subscriber to be integrated which the network subscriber with the intention of integrating into the ad-hoc network transmits back.

In the second embodiment of the invention, the selected network subscriber also transmits information searching for a network subscriber to be integrated. The identification of the cluster, which intends to join the respective cluster time-synchronised with the ad-hoc network is concluded with the reception of the acknowledgement of the information searching for a network subscriber to be integrated, which the network subscriber of the cluster with the intention of integrating into the ad-hoc network positioned in the transmission and/or reception range of the selected network subscriber transmits back.

In a second preferred variant of the invention, which can also be realised both in the first embodiment and also in the second embodiment of the invention, the search for a cluster time-synchronised with the ad-hoc network which an individual network subscriber or a cluster of mutually time-synchronised network subscribers intends to join is implemented by the single network subscriber or a network subscriber associated with the cluster of mutually time-synchronised network subscribers which is positioned respectively in the transmission and/or reception range of the selected network subscriber of the respective cluster time-synchronised with the ad-hoc network.

The individual network subscriber or network subscriber of a cluster of mutually time-synchronised network subscribers positioned in the transmission and/or reception range of a selected network subscriber of a cluster time-synchronised with the ad-hoc network preferably transmits information

searching for a time-synchronised cluster in order to integrate into a cluster time-synchronised with the ad-hoc network. The identification of the individual network subscriber or of the cluster of mutually time-synchronised network subscribers which intend to integrate into the respective cluster time-synchronised with the ad-hoc network is concluded with the reception of the information searching for a time-synchronised cluster and a subsequent acknowledgement of this received information by the selected network subscriber of the respective cluster.

The transmission of the information searching for a network subscriber to be integrated, the information searching for a time-synchronised cluster and the acknowledgement of this information is preferably implemented in second time intervals provided for this purpose, which each comprise a consistent, minimum possible duration with regard to an optimised transmission efficiency and with regard to a minimised reconnaissance or disturbance of the integration of network subscribers into the ad-hoc network by any unauthorised third party, and are repeated in a time cycle considerably longer than the cycle of the time synchronisation.

Through the integration of new network subscribers into existing clusters of the ad-hoc network, clusters of networks can arise, which do not provide an individual network subscriber which has a direct transmission connection (so-called one-hop transmission) with every other network subscriber of the newly formed cluster. In this case, in order to avoid the impossibility of time synchronisation of all network subscribers of the newly formed cluster arising in this manner, the newly formed cluster is preferably divided into several sub-clusters, which each provide at least one network subscriber which has a direct transmission connection

with every other network subscriber of the accordingly divided cluster and can therefore realise a time synchronisation with the other network subscribers of the divided cluster.

Finally, the network subscribers newly integrated into a cluster are preferably time-synchronised directly or after an optionally implemented division of the cluster newly formed through integration with the other network subscribers of the newly formed, divided or undivided cluster by a network subscriber with a direct transmission connection with all of the subscribers of the newly formed divided or undivided cluster.

The individual preferred embodiments, variants and sub-variants of the method according to the invention for integrating network subscribers into a time-synchronised ad-hoc network and an associated ad-hoc network according to the invention are explained in detail below by way of example with reference to the drawings. The figures of the drawings show:

Figure 1 a view of a mobile ad-hoc network subdivided into several clusters;

Figure 2A a view of a cluster of a mobile ad-hoc network and of a network subscriber to be integrated into the cluster, before the integration;

Figure 2B a view of a cluster of a mobile ad-hoc network and of a network subscriber to be integrated into the cluster, after the integration;

Figure 3A a view of a cluster of a mobile ad-hoc network and of a further cluster to be integrated into the cluster, before the integration;

Figure 3B a view of a cluster of a mobile ad-hoc network and of a further cluster to be integrated into the cluster, after the integration;

Figure 4 a flow diagram of an exemplary embodiment of a method according to the invention for integrating network subscribers into a time-synchronised ad-hoc network and

Figure 5 a time flow diagram showing first and second time intervals.

The following section explains in detail the method according to the invention for integrating network subscribers into a time-synchronised ad-hoc network on the basis of the flow diagram in Figure 4 and the associated ad-hoc network according to the invention starting from Figure 1, also taking into consideration Figures 2A, 2B, 3A and 3B:

In the first method step S10 of the method according to the invention as shown in Figure 1, groupings - so-called clusters - 30, 40, 50, 60, 70 and 80, in each case of regionally adjacent network subscribers 1, 2, 3, …, 18, 19 and 20 are formed in an ad-hoc network 100 which, at a given time, comprises a given number of network subscribers 1, 2, 3, …, 18, 19 and 20 - for example, mobile radio devices which exchange voice and/or data with one another.

The formation of the clusters 30, 40, 50, 60, 70 and 80 is preferably implemented in such a manner that a data transmission with the other network subscribers of the respective cluster can be implemented in an individual transmission step – a so-called one-hop transmission - via a

central network subscriber of the cluster - in Figure 1 the network subscriber 1 or 2 in cluster 30, the network subscriber 3 in cluster 40, the network subscriber 18 in cluster 50, the network subscriber 10, 12 or 13 in cluster 60, the network subscriber 5 in cluster 70 and the network subscriber 14 or 17 in cluster 80.

The knowledge about the topology of the ad-hoc network and accordingly about the relative positions of the individual network subscribers in the ad-hoc network, which is available to every network subscriber of the ad-hoc network within the framework of a proactive routing method, can be used for the formation of the individual clusters. Typically, one network subscriber which is not time-synchronised at the initialisation time of the ad-hoc network with any other network subscriber of the ad-hoc network and is therefore not yet integrated in a cluster of mutually associated network subscribers, transmits a synchronisation signal to all network subscribers which are positioned in the transmission and/or reception range of the transmitting network subscriber. After an acknowledgement of the synchronisation signal, which is typically a synchronisation bit sequence known to all network subscribers of the ad-hoc network, a cluster of network subscribers is generated by the network subscribers disposed in a direct transmission connection with the transmitting network subscriber. Identification features of the respective network subscribers are also typically exchanged with the transmission of the synchronisation signal and the associated acknowledgement, if these are necessary for the formation of a cluster of network subscribers.

According to method step S20, the first time synchronisation of all network subscribers within each cluster of network subscribers has already been implemented with the generation

of individual clusters of respective, regionally adjacent network subscribers in a mobile ad-hoc network 100. Since the topology in a mobile ad-hoc network 100, and accordingly the position of the individual network subscribers, can change continuously, a repeated time synchronisation of all network subscribers within one cluster must be implemented according to method step S20.

This time synchronisation is implemented as shown in Figure 5 in individual, first time intervals Z_1 with a minimum possible duration ΔZ_1, which are spaced in time spacings dZ_1 statistically fluctuating relative to one another in order to minimise any disturbance of the time synchronisation by an unauthorised third party. If the composition of a cluster in each case comprising regionally adjacent network subscribers does not change over a relatively long period, the time synchronisation to be implemented in successive first time spacings dZ_1 can be suspended in order to achieve optimised transmission efficiency in the ad-hoc network.

Alongside this time synchronisation within the individual clusters or groupings of the ad-hoc network – a so-called intra-time-synchronisation - a time synchronisation between the individual clusters or groupings of the ad-hoc network – a so-called inter-time-synchronisation - is also desirable in order to guarantee a time synchronicity between all network subscribers of the ad-hoc network 100. A detailed description of the inter-time-synchronisation will not be given at this point, because it is not substantial to the actual concept of the invention. The inter-time-synchronisation is presupposed per se and can be found, for example in WO 2011/154911 A1, the disclosure of which is accordingly included by referencing.

In the next method step S30, in each cluster 30, 40, 50, 60, 70 and 80 formed of respective, regionally adjacent network subscribers, one network subscriber is selected, which is positioned at the periphery of the respective cluster, and potential network subscribers for integration into the home cluster are identified. For example, in the cluster 70 of Figure 1, network subscribers 6, 7 and 8 are selected as network subscribers which are responsible for identifying network subscribers to be integrated. Once again, in order to prevent any disturbance of the integration of new network subscribers into existing time-synchronised clusters of network subscribers and accordingly into the time-synchronised ad-hoc network as far as possible, the identification processes to be implemented respectively in successive first time intervals Z_1 are implemented in each case by another selected network subscriber of the respective time-synchronised cluster.

The value of the identification number of the respective network subscriber in the ad-hoc network is used, for example, for the sequence in which network subscribers positioned at the periphery of the respective clusters are selected according to the invention. Other criteria for the sequence in which network subscribers at the periphery of the respective cluster are selected for the identification of network subscribers to be integrated can also be used as an alternative and are also covered by the invention.

Alongside the criterion of position at the periphery of a respective cluster for selecting the network subscriber for the identification of network subscribers to be integrated, network subscribers which are positioned within the transmission and/or reception range of a maximum of a previously specified number of network subscribers associated

with another cluster of the ad-hoc network should preferably be selected. In particular, those network subscribers should ideally be selected for an identification of network subscribers to be integrated which are positioned outside the transmission and/or reception range of every network subscriber of all other clusters of the ad-hoc network. In this manner, it is more probable that such a selected network subscriber identifies network subscribers to be integrated into its cluster which do not already belong to another cluster of the ad-hoc network.

In the next method step S40, the identification of network subscribers to be integrated in a respective cluster of the ad-hoc network 100 is implemented by a selected network subscriber of the respective cluster.

In a first variant of the invention, the initiative of identifying network subscribers to be integrated in a cluster of the ad-hoc network is taken by the network subscriber selected in the respective cluster. For this purpose, the selected network subscriber transmits, within a second time interval, information searching for a network subscriber to be integrated.

The fixed time spacings dZ_2 between the individual second time intervals Z_2 and the fixed durations ΔZ_2 of the individual second time intervals Z_2 according to Figure 5 are specified in advance by the ad-hoc network 100 and communicated to the individual network subscribers of the ad-hoc network 100. In this context, the time spacings dZ_2 between the individual second time intervals Z_2 are dimensioned to be significantly longer than the time spacings dZ_1 between the individual first time intervals Z_1, since the duration ΔZ_2 of a second time interval Z_2 by comparison with the duration ΔZ_1 of a first time

interval Z_1 should be dimensioned to be significantly longer, and accordingly, the transmission efficiency in the ad-hoc network 100 is held at a reasonable level.

Individual network subscribers, which are not yet time-synchronised with the ad-hoc network 100 and are positioned within the transmission and/or reception range of the selected network subscriber (the individual network subscriber 21 is disposed within the transmission and/or reception range of the selected network subscriber 7 illustrated with dotted lines in Figure 2A), or network subscribers, which belong to a cluster of mutually time-synchronised network subscribers which is not yet time-synchronised with the ad-hoc network 100, and are positioned within the transmission and/or reception range of the selected network subscriber (the network subscriber 21, which is associated with the cluster of mutually time-synchronised network subscribers 21, 22 and 23, is disposed within the transmission and/or reception range of the selected network subscriber 7 illustrated with a dotted line in Figure 3A) acknowledge the received information searching for a network subscriber to be integrated within the second time interval Z_2. With the reception of the acknowledgement, the identification of network subscribers to be integrated into the respective cluster by the network subscriber selected in the respective cluster is substantially completed. Together with the acknowledgement of the information searching for a network subscriber to be integrated, the network subscriber selected in the respective cluster receives identification data of the network subscriber to be integrated.

In a second variant of the invention, the initiative of identifying network subscribers to be integrated in a cluster of the ad-hoc network is taken by the individual network subscriber which is not yet integrated in a cluster of network

subscribers of the time-synchronised ad-hoc network 100 and intends to integrate, or by a network subscriber which is associated with a cluster of mutually time-synchronised network subscribers which is not yet associated with a cluster of network subscribers of the time-synchronised ad-hoc network 100 or not yet time-synchronised with the ad-hoc network 100 and intends to integrate. The individual network subscriber intending to integrate or the network subscriber associated with a cluster of time-synchronised network subscribers intending to integrate, which is/are positioned respectively within the transmission and/or reception range of a selected network subscriber in a cluster time-synchronised with the ad-hoc network, each transmit/s information searching for a time-synchronised cluster within a second time interval Z_2.

The identification of an individual network subscriber or of a cluster of mutually time-synchronised network subscribers to be integrated into a cluster in each case of regionally adjacent network subscribers time-synchronised with the ad-hoc network is concluded with the reception of the information searching for a time-synchronised cluster and the transmission of an acknowledgement of this information by the selected network subscriber of a cluster time-synchronised with the ad-hoc network. Together with the reception of the information searching for a time-synchronised cluster, the respectively selected network subscriber additionally receives identification data regarding the network subscriber to be integrated, while the network subscribers to be integrated receive identification data of the network subscribers already contained in the respective cluster together with the acknowledgement of the information.

In the next method step S50, an appropriate division of the clusters of network subscribers enlarged by the integration of

at least one network subscriber is optionally implemented if no individual network subscriber is identifiable in a cluster of network subscribers modified in this manner which provides a direct transmission connection to all of the other network subscribers of such a modified cluster of network subscribers. This division of a cluster of network subscribers formed in this manner is necessary, since a time synchronisation of all network subscribers in a cluster of network subscribers formed in this manner is not possible. In dividing such a cluster of network subscribers, clusters of network subscribers must therefore be formed, which, in each case, contain at least one network subscriber which provides a direct transmission connection with all of the other network subscribers of the divided cluster of network subscribers.

The cluster 70’ of network subscribers illustrated in Figure 2B and the cluster 70’’ of network subscribers illustrated in Figure 3B represent examples of clusters of network subscribers divided in such a manner, which provide a network subscriber which is disposed in a direct transmission connection with all of the other network subscribers of the divided cluster of network subscribers. In cluster 70’ of Figure 2B, this is network subscriber 7, and in cluster 70’’ of Figure 3B, it is network subscriber 21.

In the final method step S60, the network subscribers integrated in the individual divided or undivided clusters of network subscribers are time-synchronised, via a network subscriber which is disposed in a direct transmission connection with all other network subscribers of the respective divided or undivided cluster of network subscribers, with the other network subscribers of the respective divided or undivided cluster of network subscribers through the transmission of information for the time

synchronisation, preferably a coded synchronisation bit sequence.

The invention is not restricted to the embodiments, variants and sub-variants presented. In particular, all combinations of all of the features claimed in the individual claims, all of the features disclosed in the description and all of the features illustrated in the figures of the drawings are also covered by the invention.

CLAIMS

1. A method for integrating network subscribers into a time-synchronized ad-hoc network, comprising:

forming at least one cluster, each comprising a plurality of regionally adjacent network subscribers;

time synchronizing the network subscribers within each cluster;

selecting at least one network subscriber at a periphery of a respective one of the clusters in order to identify one or more further network subscribers to be integrated into the respective cluster; and

time synchronizing the network subscribers of the respective cluster, to which the one or more further network subscribers are to be integrated, with each of the one or more network subscribers to be integrated in the respective cluster; and

wherein the time synchronization of the network subscribers within each cluster is performed within a first time interval (Z_1) of a fixed length (ΔZ_1), which are spaced from one another with a statistically fluctuating time spacing (dZ_1).

2. The method according to claim 1, wherein the identification of the one or more further network subscribers to be integrated into the respective cluster is performed repeatedly, in each case with a different selected network subscriber.

3. The method according to claim 1, wherein the selected network subscriber is selected from network subscribers of a cluster that are positioned within a transmission and/or reception range of a previously specified maximum number of network subscribers each associated with another cluster.

4. The method according to claim 1, wherein the selected network subscriber is selected from network subscribers of a cluster which are positioned outside of a transmission and/or reception range of each network subscriber of all other clusters.

5. The method according to claim 1, wherein the time synchronization of the network subscribers within each cluster is performed by a network subscriber of the respective cluster that is positioned in a transmission and/or reception range of all other network subscribers of the respective cluster, and wherein, in a first time interval (Z_1), the network subscriber of the respective cluster transmits an information known to all network subscribers of the ad-hoc network for the time synchronization.

6. The method according to claim 1, wherein the time synchronization of the network subscribers within each cluster is omitted if the number of network subscribers in a cluster is not changed.

7. The method according to claim 1, wherein the selected network subscriber transmits an information searching for a network subscriber to be integrated in order to identify at least one network subscriber to be integrated into the respective cluster.

8. The method according to claim 7, wherein a network subscriber that is located in a transmission and/or reception range of the selected network subscriber and intends to integrate itself into the ad-hoc network acknowledges the information searching for a network subscriber to be integrated in order to identify a network subscriber to be integrated into the respective cluster.

9. The method according to claim 7, wherein a network subscriber that is located in a transmission and/or reception range of the selected network subscriber, and belongs to a cluster of network subscribers that are synchronized with one another and intend to integrate themselves into the ad-hoc network, acknowledges the information searching for a network subscriber to be integrated in order to identify the network subscribers to be integrated into the respective cluster.

10. The method according to claim 1, wherein one of an individual network subscriber and a network subscriber associated with a cluster of mutually synchronized network subscribers, which intend/s to integrate itself or themselves into the ad-hoc network, transmits an information searching for a time-synchronized cluster.

11. The method according to claim 10, wherein a selected network subscriber of a time-synchronized cluster, which is disposed in the transmission and/or reception range of the network subscriber transmitting the information searching for a time-synchronized cluster, acknowledges the information searching for a time-synchronized cluster in order to identify the network subscriber or subscribers to be integrated into the respective cluster.

12. The method according to claim 8, wherein the transmission of the information searching for a network subscriber to be integrated, the information searching for a time-synchronized cluster and the acknowledgement is performed within time intervals Z_2.

13. The method according to claim 1, wherein, after the identification of the one or more further network subscribers to be integrated into the respective cluster, each cluster is divided as required into several clusters in order to provide clusters in which at least one network subscriber is available in each case within a transmission and/or reception range of all of the other network subscribers of the cluster.

14. The method according to claim 13, wherein the time synchronization of the network subscribers of each of the at least one cluster, to which the one or more further network subscribers are to be integrated, with each of the one or more network subscribers to be integrated in the respective cluster, which is either undivided or divided, is performed within a first time interval (Z_1) following respectively after a second time interval (Z_2).

15. An ad-hoc network, comprising:

at least one cluster, each comprising a plurality of regionally adjacent network subscribers,

wherein the network subscribers within each cluster are time-synchronized via a

synchronization performed within a first time interval (Z_1) of a fixed length (ΔZ_1), which are spaced from one another with a statistically fluctuating time spacing (dZ_1); and

at least one selected network subscriber located at a periphery of a respective one of the clusters, wherein the at least one selected network subscriber is selected for a determination of one or more further network subscribers to be integrated into the respective cluster; and

wherein the network subscribers of the respective cluster, to which the one or more further network subscribers are to be integrated, are time-synchronized with each of the one or more network subscribers to be integrated in the respective cluster.

16. The ad-hoc network according to claim 15, wherein the selected network subscribers are each positioned within a transmission and/or reception range of a previously specified maximum number of network subscribers each associated with another time-synchronized cluster of the ad-hoc network.

17. The ad-hoc network according to claim 15, wherein the selected network subscribers are each positioned outside of a transmission and/or reception range of each network subscriber of all of the other time-synchronized clusters.