

Claims

1. A method for time synchronisation in a mobile ad-hoc network with the following method steps:

- 5 - transmission by every node ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) of the mobile ad-hoc network of a message signalling a presence (1), in each case within a given time frame,
- 10 - acknowledgement by every node ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) disposed within the transmission range of the transmitting node ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) of the received message signalling a presence (1), in each case with an acknowledgement message (2),
- 15 - specification of that node ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) of two nodes ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) disposed within the transmission range of one another with the local time of which the respectively other node ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) synchronises its local time, on the basis of information in an acknowledgement message (2) which is received by one of the two nodes ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) and
- 20 - synchronisation of the local time of the nodes ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) with the local time of the respective specified node ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$).

25 2. The method according to claim 1,

characterised in that,

of the two nodes ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) disposed within the transmission range of one another, that node ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) is specified, of which the local time provides the maximum time accuracy or which is

30 integrated in another ad-hoc network with a node ($3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8$) of which the local time provides the maximum time accuracy.

3. The method according to claim 1 or 2,
characterised in that,

in the case of an ad-hoc network formed from only two nodes (3_1 , 3_2) of which the local times provide an identical time accuracy, that node (3_1 , 3_2) is specified which first transmits an acknowledgement message (2) to a message signalling a presence (1) of the two nodes (3_1 , 3_2).

4. The method according to any one of claims 1 to 3,
characterised in that,

in the case of an identical time accuracy of all of the nodes (3_1 , 3_2 , 3_3 , 3_4 , 3_5 , 3_6 , 3_7 , 3_8) integrated in the ad-hoc network to be formed, that node of the two nodes (3_1 , 3_2 , 3_3 , 3_4 , 3_5 , 3_6 , 3_7 , 3_8) disposed within the transmission range of one another is specified which already forms an ad-hoc network with a relatively larger number of nodes (3_1 , 3_2 , 3_3 , 3_4 , 3_5 , 3_6 , 3_7 , 3_8).

5. The method according to any one of claims 1 to 4,
characterised in that,

in the case of an identical time accuracy of all of the nodes (3_1 , 3_2 , 3_3 , 3_4 , 3_5 , 3_6 , 3_7 , 3_8) integrated in the ad-hoc network to be formed and with an identical number of nodes (3_1 , 3_2 , 3_3 , 3_4 , 3_5 , 3_6 , 3_7 , 3_8) with which the two nodes disposed within the transmission range of one another each form an ad-hoc network, that node (3_1 , 3_2 , 3_3 , 3_4 , 3_5 , 3_6 , 3_7 , 3_8) is specified of which the ad-hoc network provides a relatively lower identity code.

6. The method according to claim 5,
characterised in that

the identity code of the ad-hoc network is the Medium-Access-Control address of the ad-hoc network.

7. The method according to any one of claims 1 to 6,

characterised in that,

in the case of an ad-hoc network from which at least one
node (3_1) is removed, that node ($3_2, 3_3, 3_4$) of the
remaining ad-hoc network which provides the local time
with the maximum time accuracy is specified, with the
local time of which the remaining nodes ($3_2, 3_3, 3_4$) of the
ad-hoc network each synchronise their local time.

8. The method for time synchronisation according to claim 7,

characterised in that,

in the case of an ad-hoc network from which at least one
node (3_1) is removed and in the case of an identical time
accuracy of the local times of the nodes ($3_2, 3_3, 3_4$) of
the remaining ad-hoc network, that node ($3_2, 3_3, 3_4$) of the
remaining ad-hoc network is specified which provides the
maximum number of directly adjacent nodes ($3_2, 3_3, 3_4$).

9. The method according to claim 7 or 8,

characterised in that,

in the case of an ad-hoc network from which at least one
node (3_1) is removed and in the case of an identical time
accuracy of the local times of the nodes ($3_2, 3_3, 3_4$) of
the remaining ad-hoc network and in the case of an
identical number of respectively directly adjacent nodes
($3_2, 3_3, 3_4$) for each node ($3_2, 3_3, 3_4$) of the remaining ad-
hoc network, that node ($3_2, 3_3, 3_4$) of the remaining ad-hoc
network is specified which provides the lowest identity
code.

10. The method according to any one of claims 1 to 6,

characterised in that

a node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ of an ad-hoc network from which a node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$, with the local time of which the node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ of the ad-hoc network previously synchronised its local time, is removed, specifies another node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ of the remaining ad-hoc network disposed within its transmission range, with the local time of which it synchronises its local time.

11. The method according to any one of claims 1 to 10, **characterised in that**

the synchronisation of the local time of the nodes $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ which each form an ad-hoc network with one of the two nodes $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ disposed within the transmission range of one another is realised at the local time of the specified node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$, in that every node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ of the respective ad-hoc network specifies a directly adjacent node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ of the ad-hoc network as the node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ with the local time of which it synchronises its local time.

12. The method according to any one of claims 1 to 11, **characterised in that**

the synchronisation of the local time of a node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ with the local time of the specified node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ is implemented in that the specified node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ communicates to the node the reception time of the message transmitted from the node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ in order to update a presence (1) or an acknowledgement message (2) at the local time of the specified node $(3_1, 3_2, 3_3, 3_4, 3_5, 3_6, 3_7, 3_8)$ and the transmission time of a

message transmitted to the node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) in order to signal a presence (1) or an acknowledgement message (2).

5 13. The method according to claim 12,

characterised in that

the synchronisation of the local time of a node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) with the local time of the specified node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) takes place with every
10 reception of a message signalling a presence (1) or an acknowledgement message (2) of the specified node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈).

14. The method according to any one of claims 7 to 9,

15 **characterised in that**

the removal of a node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) from an ad-hoc network is identified if no further message signalling a presence (1) of the moving node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) has been received from any of the other
20 nodes (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) of the remaining ad-hoc network since the last reception time of a message signalling a presence (1) of the moving node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) within a constant time frame in which, respectively, a message signalling a presence (1) is
25 transmitted.

15. The method according to any one of claims 1 to 14,

characterised in that

a constant time frame in which the node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) transmits a message updating a presence (1) is
30 minimised in order to reduce the influence of a clock-pulse drift on the time accuracy of the local time of a node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈).

16. The method according to claim 15,

characterised in that

the node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) calculates the transmission time of the message updating a presence (1) in order to limit the influence of the clock-pulse drift on the time accuracy of the local time of the node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈).

17. A system for time synchronisation within a mobile ad-hoc

network comprising several nodes (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) each transmitting a message signalling a presence (1),

in each case within a given time frame, whereas an acknowledgement of the message signalling a presence (1) is implemented by means of an acknowledgement message (2)

by every node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) disposed within the transmission range of the node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) transmitting a message signalling a presence (1), whereas, in each case from two nodes (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) disposed within the transmission range of

one another, a node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) is specified with the local time of which the local time of the respectively other node (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) is synchronised, whereas the specification of the node (3₁,

3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) is implemented on the basis of information in the acknowledgement message (2) received from one of the two nodes (3₁, 3₂, 3₃, 3₄, 3₅, 3₆, 3₇, 3₈) disposed within the transmission range of one another.

Claims

1. A method for time synchronization in a mobile ad-hoc network, comprising:
 - transmitting by every node of the mobile ad-hoc network of a message signalling a presence, in each case within a given time frame,
 - acknowledging by every node disposed within the transmission range of the transmitting node of the received message signalling a presence, in each case with an acknowledgement message,
 - specifying of that node of two nodes disposed within the transmission range of one another with the local time of which the respectively other node synchronizes its local time, on the basis of information in an acknowledgement message which is received by one of the two nodes, and
 - synchronizing of the local time of the nodes with the local time of the respective specified node,
 - wherein of the two nodes disposed within the transmission range of one another, that node is specified, of which the local time provides maximum time accuracy or which is integrated in another ad-hoc network with a node of which the local time provides the maximum time accuracy.
2. The method according to claim 1, wherein in the case of an adhoc network formed from only two nodes of which the local times provide an identical time accuracy, that node is specified which first transmits an acknowledgement message to a message signalling a presence of the two nodes.
3. The method according to claim 1, wherein in the case of an identical time accuracy of all of the nodes integrated in the ad-hoc network to be formed, that node of the two nodes disposed within

the transmission range of one another is specified which already forms an ad-hoc network with a relatively larger number of nodes.

4. The method according to claim 1, wherein in the case of an identical time accuracy of all of the nodes integrated in the ad-hoc network to be formed and with an identical number of nodes with which the two nodes disposed within the transmission range of one another each form an ad-hoc network, that node is specified of which the ad-hoc network provides a relatively lower identity code.
5. The method according to claim 4, wherein the identity code of the ad-hoc network is the Medium-Access-Control address of the ad-hoc network.
6. The method according to claim 1, wherein in the case of an adhoc network from which at least one node is removed, that node of the remaining ad-hoc network which provides the local time with the maximum time accuracy is specified, with the local time of which the remaining nodes of the ad-hoc network each synchronize their local time.
7. The method for time synchronization according to claim 6, wherein in the case of an ad-hoc network from which at least one node is removed and in the case of an identical time accuracy of the local times of the nodes of the remaining ad-hoc network, that node of the remaining ad-hoc network is specified which provides the maximum number of directly adjacent nodes.
8. The method according to claim 6, wherein in the case of an adhoc network from which at least one node is removed and in the case of an identical time accuracy of the local times of the nodes of the remaining ad-hoc network and in the case of an identical number of respectively directly

adjacent nodes for each node of the remaining ad-hoc network, that node of the remaining ad-hoc network is specified which provides the lowest identity code.

9. The method according to claim 1, wherein a node of an ad-hoc network from which a node, with the local time of which the node of the ad-hoc network previously synchronized its local time, is removed, specifies another node of the remaining ad-hoc network disposed within its transmission range, with the local time of which it synchronizes its local time.
10. The method according to claim 1, wherein the synchronization of the local time of the nodes which each form an ad-hoc network with one of the two nodes disposed within the transmission range of one another is realized at the local time of the specified node, in that every node of the respective ad-hoc network specifies a directly adjacent node of the ad-hoc network as the node with the local time of which it synchronizes its local time.
11. The method according to claim 1, wherein the synchronization of the local time of a node with the local time of the specified node is implemented in that the specified node communicates to the node the reception time of the message transmitted from the node in order to update a presence or an acknowledgement message at the local time of the specified node and the transmission time of a message transmitted to the node in order to signal a presence or an acknowledgement message.
12. The method according to claim 11, wherein the synchronization of the local time of a node with the local time of the specified node takes place with every reception of a message signalling a presence or an acknowledgement message of the specified node.
13. The method according to claim 6, wherein the removal of a node from an ad-hoc network is identified if no further message signalling a presence of the moving node has been received from any of the other nodes of the remaining ad-hoc network since the last reception time of a message

signalling a presence of the moving node within a constant time frame in which, respectively, a message signalling a presence is transmitted.

14. The method according to claim 1, wherein a constant time frame in which the node transmits a message updating a presence is minimised in order to reduce the influence of a clock-pulse drift on the time accuracy of the local time of a node.

15. The method according to claim 14, wherein the node calculates the transmission time of the message updating a presence in order to limit the influence of the clock-pulse drift on the time accuracy of the local time of the node.

16. A system for time synchronization within a mobile ad-hoc network comprising several nodes each transmitting a message signalling a presence, in each case within a given time frame,
whereas an acknowledgement of the message signalling a presence is implemented by means of an acknowledgement message by every node disposed within the transmission range of the node transmitting a message signalling a presence,

whereas, in each case from two nodes disposed within the transmission range of one another, a node is specified with the local time of which the local time of the respectively other node is synchronized,

whereas the specification of the node is implemented on the basis of information in the acknowledgement message received from one of the two nodes disposed within the transmission range of one another, and

whereas of the two nodes disposed within the transmission range of one another, that node is specified, of which the local time provides maximum time accuracy or which is integrated in another ad-hoc network with a node of which the local time provides the maximum time accuracy.

17. A method for time synchronization in a mobile ad-hoc network, comprising:

transmitting by every node of the mobile ad-hoc network of a message signalling a presence, in each case within a given time frame,

acknowledging by every node disposed within the transmission range of the transmitting node of the received message signalling a presence, in each case with an acknowledgement message,

specifying of that node of two nodes disposed within the transmission range of one another with the local time of which the respectively other node synchronizes its local time, on the basis of information in an acknowledgement message which is received by one of the two nodes, and

synchronizing of the local time of the nodes with the local time of the respective specified node,

wherein in the case of an ad-hoc network formed from only two nodes of which the local times provide an identical time accuracy, that node is specified which first transmits an acknowledgement message to a message signalling a presence of the two nodes.