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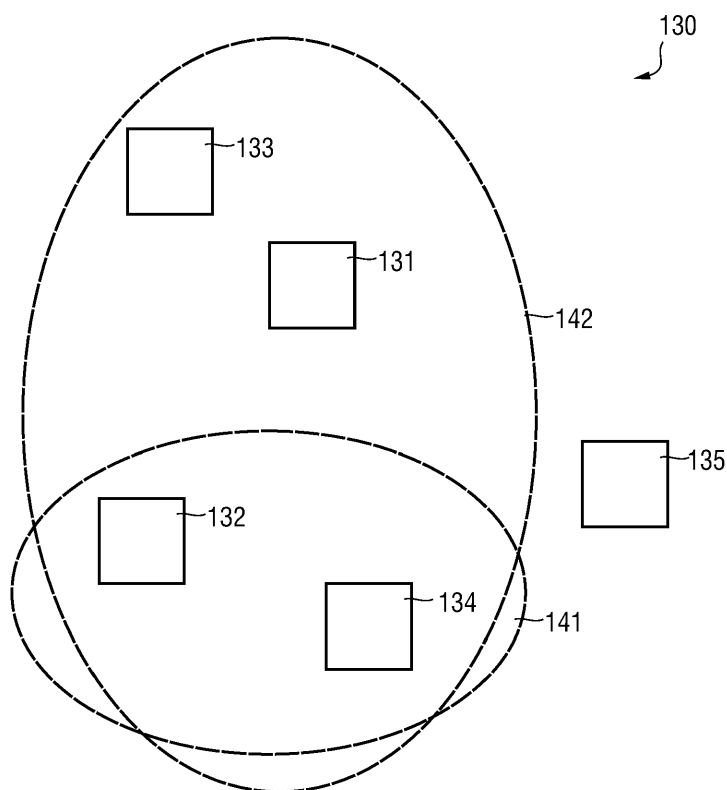
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(54) **MESSAGE DELIVERY IN LUMINAIRE WIRELESS COMMUNICATION NETWORKS**

(57) Various examples of the disclosure pertain to selecting between different message delivery modes for transmitting messages in a wireless communication network of luminaires.

FIG. 1



Description

TECHNICAL FIELD

[0001] Various examples of the disclosure generally pertain to a wireless communication network of luminaires. Various examples of the disclosure specifically pertain to selecting a message delivery mode for delivering messages to luminaires of the wireless communication network. For example, a selection between multicast and unicast message delivery modes can be made.

BACKGROUND

[0002] Recently, the use of wireless communication networks for controlling luminaires is proliferating. For instance, luminaires can be wirelessly controlled to switch on or switch off or activate a certain brightness level (dimmer).

[0003] However, due to the widely varying deployment scenarios that are observed - e.g., both in terms of in terms of the size of the wireless communication network, number of repeaters, coverage situation, etc. - it has been observed that delivery of certain messages can be sometimes delayed beyond an acceptable time duration due to unreliable radio channels. Also, sometimes certain restrictions or constraints limit the possibility to employ more robust or low-latency message delivery.

SUMMARY

[0004] Accordingly, a need exists for advanced techniques of delivering messages in a wireless communication network of luminaires.

[0005] This need is met by the features of the independent claims. The features of the dependent claims define embodiments.

[0006] According to an example, a method of operating a node of a wireless communication network of luminaires is provided. The method includes selecting a message delivery mode for one or more messages to be transmitted to multiple luminaires of the network. The message delivery mode is selected from a plurality of message delivery modes. Such selection depends on one or more decision criteria. Then, the one or more messages are transmitted to the multiple luminaires in accordance with the selected message delivery mode.

[0007] For instance, the node could be a control node. The node can be a repeater node. The node can be a luminaire node, i.e., include lighting functionality. The node can be coupled to a presence detector that detects presence of persons in a surveillance region.

[0008] According to various examples, it is possible to decide, at the node, how to deliver the message. In other words, it may be possible to dynamically adapt the message delivery mode depending on one or more circumstances that are dynamically captured by the one or more decision criteria. Ad-hoc decision making is possible.

[0009] Thereby, the message delivery mode can be tailored to the particular deployment scenario or even the current coverage scenario of the wireless communication network.

[0010] Different wireless communication networks - albeit operating in accordance with the same communication protocol and employing the same transmission protocol stack - can use different message delivery modes. It is even possible that within one and the same wireless communication network different message delivery modes are selected, e.g., for different messages and/or at different times.

[0011] Different message delivery modes are typically associated with different reliabilities and latencies. Thereby, the transmission reliability and/or transmission latency can be tailored.

[0012] According to the various scenarios, different types of message delivery modes are considered. Some examples are discussed below.

[0013] In one example, the plurality of message delivery modes include one or more unicast message delivery modes and one or more multicast message delivery modes.

[0014] Unicast and multicast message delivery are two different ways of transmitting messages in the wireless communication network. Unicast message delivery is a one-to-one communication method, in which a message is sent from a single sender to a single receiver. In this type of communication, the sender sends a message to a specific receiver's address, and only that receiver will receive the message. Where a message is to be delivered to multiple recipients using unicast message delivery mode, multiple instances of that message are transmitted one after another.

[0015] Multicast message delivery is a one-to-many communication method, in which a message is sent from a single sender to multiple receivers. In this type of communication, the sender sends (a single instance of) the message to a multicast group address, and all the receivers that are part of that group receive that message.

[0016] As a general rule, the multicast message delivery mode and the unicast message delivery mode can be defined on various layers of a transmission protocol stack employed by the wireless communication network. For instance, it would be possible that the multicast message delivery mode and the unicast message delivery mode are defined on the Network Layer in accordance with the Open Systems Interface (OSI) model. For instance, it would be possible to rely on Internet Protocol (IP) multicast and IP unicast for these two message delivery modes, respectively.

[0017] IP unicast and IP multicast are both defined in the IP standard, which is part of the TCP/IP protocol suite. The IP standard is defined in the Network Working Group Request for Comments (RFC) 791, which describes the basic IP protocol, including the addressing scheme used for unicast communication. IP multicast is defined in RFC 1112. These RFCs are for IPv4. For IPv6, see RFC 1883

RFC 3810 RFC 7346.

[0018] By selecting between one or more multicast message delivery modes and one or more unicast message delivery modes, a tradeoff between reliability, timely delivery, and reduced network load can be achieved. Network security concerns can be taken into account, e.g., by disabling multicast delivery altogether.

[0019] A further example of a type of message delivery modes is associated with the number of repetitions for each message. For instance, the plurality of message delivery modes can include one or more low-repetition message delivery modes and one or more high-repetition message delivery modes. The number of repetitions per message is higher for the high-repetition message delivery modes than for the low-repetition delivery modes. To give an example, it would be possible that each of the one or more low-repetition message delivery modes has a number of repetitions that is not larger than 5 or 10; while each of the one or more high-repetition message delivery modes has a number of repetitions that is not smaller than 5 or 10.

[0020] By tailoring the amount of repetitions per message, an overall balance between, firstly, network load and, secondly, delivery reliability can be achieved.

[0021] Above, two examples of message delivery modes have been disclosed. A first type of message delivery mode from which the message delivery mode to be used for transmitting can be selected is the unicast versus multicast message delivery mode: a second type pertains to the number of repetitions. However, there are further types of message delivery modes that may be used alternatively or additionally. For instance, error protection can be tailored. For instance, forward error correction may be activated or deactivated or a checksum length may be adjusted. Such error protection functionality can be set at Layer 2 of the OSI transmission protocol stack. Yet another option for a type of message delivery modes from which it is possible to select pertains to one or more parameters set at Layer 1 of the OSI transmission protocol stack. For instance, a transmit power or a modulation scheme may be adjusted. For instance, it may be possible to change the constellation of the modulation scheme. Thereby, more robust, low-throughput constellations can be selected in a certain case, while less robust, high-throughput constellations can be selected in other cases.

[0022] As a general rule, similar to or along with the number of options available for implementing the message delivery mode, a number of options are available for one or more decision criteria based on which the selection of the message delivery mode is made.

[0023] In particular, it has been found that for wireless communication networks of luminaires, oftentimes, messages are to be delivered to a significant number of recipients, i.e., to a significant number of luminaires. For instance, in apartment buildings or high-rises, a comparatively large number of luminaires may be required to receive a certain message. Accordingly, the one or more

decision criteria can include a number of recipients of the one or more messages. In other words, depending on how many recipients each of the one or more messages has, a different message delivery mode can be selected. For example, a multicast message delivery mode can be selected upon the number of recipients of the one or more messages being above a predefined threshold; while a unicast message delivery mode can be selected upon the number of recipients of the one or more messages being below the predefined threshold. It would also be possible that, depending on the number of recipients, a selection between a low-repetition message delivery mode and a high-repetition message delivery mode is made. Such scenarios can also be combined. For instance, a first threshold comparison can be between the number of recipients and the first threshold; if the number of recipients is above the first predefined threshold, then the multicast message delivery mode can be selected. Subsequently, a second threshold comparison can be between the number of recipients and a second predefined threshold (that is larger than the first predefined threshold); if the number of recipients is also above the second predefined threshold, then a high-repetition multicast message delivery mode can be selected, or else a low-repetition multicast message delivery mode can be selected.

[0024] The number of recipients can be passed down to the respective layer of the transmission protocol stack from a higher layer. The number of recipients can be determined depending on a group size of a pre-established logical group to which the multiple luminaires being recipients of the one or messages are assigned. Oftentimes, logical groups are formed at deployment of the wireless communication network of luminaires. Common commands can be issued for all members of a certain logical group. For instance, upon detection of presence of a person in a certain area, all the luminaires of a certain logical group can be switched on or switched off. For instance, actuation of a presence button can switch on or switch of all the luminaires of a certain group. Thus, in other words, each group of luminaires can be associated with a certain message delivery mode for that group. Group-specific message delivery is thereby achieved. For instance, small groups can use unicast message delivery while large groups use multicast message delivery. Very large groups can use high-repetition multicast message delivery.

[0025] In another example, the one or more decision criteria include a quality-of-service (QoS) requirement of the one or more messages. For instance, different messages can be associated with different services. For instance, typical services supported in a wireless communication network of luminaires pertain to configuration of individual luminaires (e.g., providing certain general settings), control of individual luminaires (e.g., switching on or switching off or setting a certain brightness level), firmware update, emergency lighting, etc. Certain services can have a stricter quality of service requirement

than others. For instance, emergency lighting may require high-priority, reliable and low-latency transmission; while message is associated with firmware updates can be communicated at high-latency. Accordingly, it would be possible to take into account such QoS requirements associated with the services. QoS requirements may be expressed in terms of, e.g., bandwidth (the amount of data that needs to be transmitted over a wireless channel at a given time), latency (the maximum allowable time it takes for a message to travel from the sender to the receiver), jitter (the maximum allowable variations in message delay or latency), message loss (the percentage of message can be are lost during transmission), etc.

[0026] There are further decision criteria that are conceivable. For instance, it would be possible to determine a multicast capability of the transmission protocol stack of the wireless communication network. Some transmission protocol stacks may have multicast transmission disabled. For instance, due to security concerns, multicast transmission may be disabled in the wireless communication network. In such a scenario, it may be possible to use a fallback to unicast transmission. According to examples, it would be possible that the node repeatedly tests the multicast capability. For instance, dummy messages can be transmitted using a multicast message delivery mode and it can be checked whether such dummy messages can be delivered or not. It would be possible to re-transmit such dummy messages from time to time, e.g., in accordance with a predefined timing schedule, upon determining that at a certain point in time multicast delivery is not supported. Multicast capability may not only be disabled or unsupported at the level of the wireless communication network; alternatively or additionally, individual luminaires of the wireless communication network may not support multicast delivery. Accordingly, it would be possible to take into account the respective capability for each of the luminaires to which the messages are to be delivered.

[0027] While such capability to be considered as a decision criterion when selecting the message deliver mode has been explained above in context of the multicast message delivery mode, similar capabilities can also be taken into consideration as a decision criterion for other types of message delivery modes, as explained above.

[0028] According to various examples, the node that selects the message delivery mode to be used for transmitting the one or messages may locally use the selected message delivery mode to transmit the one or more messages. It is optionally possible that the node that selects the message delivery mode also informs other nodes of the wireless communication network that may potentially transmit similar messages to the same set of recipients accordingly. For instance, it would be possible that the node provides, to one or more further nodes of the network of luminaires, a control message that is indicative of the one or more decision criteria. Accordingly, each node that potentially transmits messages in the wireless communication network can rely on the same set of rules

for making the selection of the applicable message delivery mode. Thus, of other nodes of the wireless communication network transmit messages to other sets of luminaires or groups of luminaires, they may apply the similar one or more decision criteria to make the selection of the applicable message delivery mode. This enables the same QoS requirements - e.g., in terms of latency and reliability - to be met for various communications throughout the wireless communication network.

[0029] Alternatively or additionally, it would also be possible that the node provides to one or more further nodes of the wireless communication network, a control message indicative of the selected message delivery mode. I.e., it would be possible that the particular selection made is signaled to other nodes. In such a scenario, the other nodes need not to have knowledge regarding the underlying one or more decision criteria. The one or more decision criteria can then be transparent to the other nodes. For instance, such signaling of the control message that is indicative of the selected message delivery mode may be responsive to making the selection.

[0030] Above, scenarios have been discussed in which information associated with the selection of the message delivery mode (i.e., the particular message delivery mode that is selected and/or the underlying one or more decision criteria) have been disclosed. Some message delivery modes may not be signaled to the recipients. Examples include message delivery modes defining message transmission at the Network layer, e.g., IP unicast versus IP multicast message delivery or IP repetitions. Here, the receiver nodes can auto-configure for different message delivery modes upon receiving the messages. In some other scenarios, selection of the message delivery mode may need to be signaled to the recipients. This is because receiver functionality may need to be configured in accordance with the selected message delivery mode. Examples include Layer 1 and Layer 2 message delivery modes, e.g., modulation or coding schemes or forward-error correction configuration. In latter scenario, the node making the selection may provide a control message indicative of the selected message delivery mode or the one or more decision criteria to the one or more luminaires.

[0031] As a general rule, various trigger criteria for making the selection of the message delivery mode are conceivable. In one example, the multiple luminaires form a logical group that is associated with the lighting functionality, as explained above. In such a scenario, it would be possible that the message delivery mode is selected responsive to establishment of the group. In other words, it would be possible that each time a new group is formed/established, the associated message delivery mode for that group is determined. It would then be possible to store, e.g., in a lookup table the identities of all the luminaires that are part of the respective logical group, as well as the selected message delivery mode associated with that group. Each time a message is to be delivered to all the luminaires of a certain group, it

would be possible to make a lookup of the identities of the participating luminaires (or, instead, a group identity may be used for addressing the respective one or messages), as well as the pre-selected message delivery mode. In yet another example, it would be possible that the message delivery mode is not selected at the time of establishment of a group, but rather each time a messages to be delivered. In other words, the message delivery mode can be selected for each of the one or more messages responsive to the respective one of the one or messages arriving in a transmit buffer of the node. For instance, each time an IP packet arrives in an IP transmit buffer, a selection between IP multicast and IP unicast can be made.

[0032] A node of a wireless communication network of luminaires includes control circuitry. The control circuitry is configured to perform a method as disclosed above.

[0033] It is to be understood that the features mentioned above and those yet to be explained below may be used not only in the respective combinations indicated, but also in other combinations or in isolation without departing from the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034]

FIG. 1 schematically illustrates a wireless communication network including multiple luminaire nodes (or simply luminaires) and a control node according to various examples.

FIG. 2 is a flowchart of a method according to various examples.

FIG. 3 schematically illustrates selection of different message deliver modes depending on a number of recipients of a message according to various examples.

FIG. 4 schematically illustrates a node of a wireless communication network according to various examples.

DETAILED DESCRIPTION

[0035] Some examples of the present disclosure generally provide for a plurality of circuits or other electrical devices. All references to the circuits and other electrical devices and the functionality provided by each are not intended to be limited to encompassing only what is illustrated and described herein. While particular labels may be assigned to the various circuits or other electrical devices disclosed, such labels are not intended to limit the scope of operation for the circuits and the other electrical devices. Such circuits and other electrical devices may be combined with each other and/or separated in any manner based on the particular type of electrical im-

plementation that is desired. It is recognized that any circuit or other electrical device disclosed herein may include any number of microcontrollers, a graphics processor unit (GPU), integrated circuits, memory devices (e.g., FLASH, random access memory (RAM), read only memory (ROM), electrically programmable read only memory (EPROM), electrically erasable programmable read only memory (EEPROM), or other suitable variants thereof), and software which co-act with one another to perform operation(s) disclosed herein. In addition, any one or more of the electrical devices may be configured to execute a program code that is embodied in a non-transitory computer readable medium programmed to perform any number of the functions as disclosed.

[0036] In the following, embodiments of the invention will be described in detail with reference to the accompanying drawings. It is to be understood that the following description of embodiments is not to be taken in a limiting sense. The scope of the invention is not intended to be limited by the embodiments described hereinafter or by the drawings, which are taken to be illustrative only.

[0037] The drawings are to be regarded as being schematic representations and elements illustrated in the drawings are not necessarily shown to scale. Rather, the various elements are represented such that their function and general purpose become apparent to a person skilled in the art. Any connection or coupling between functional blocks, devices, components, or other physical or functional units shown in the drawings or described herein may also be implemented by an indirect connection or coupling. A coupling between components may also be established over a wireless connection. Functional blocks may be implemented in hardware, firmware, software, or a combination thereof.

[0038] Hereinafter, techniques of wirelessly communicating in a wireless communication network of luminaires are disclosed. In particular, options and strategies for selecting an appropriate message delivery mode for transmitting messages from one node to other nodes in the wireless communication network are disclosed. According to various examples, such message delivery modes can impact the transmission on one or more layers of a transmission protocol stack used by the wireless communication network. For instance, a message delivery mode can impact the operation of Layer 2 or Layer 3 of the transmission protocol stack, in accordance with the OSI standard.

[0039] FIG. 1 schematically illustrates a wireless communication network 130. The wireless communication network 130 includes multiple nodes 131-135. For instance, different nodes can be one or of the following: a control node; a luminaire node (or simply luminaire); a repeater node. Generally, despite the option of using the disclosed techniques at different types of nodes in the wireless communication network 130, the strategies for transmitting messages and selecting message delivery modes disclosed herein can be applicable to all such types of nodes.

[0040] In the illustrated scenario, it is assumed that the node 135 is a control node and the nodes 131-134 are luminaires. Some of the nodes 131-134 can - in addition to the lighting functionality - also provide repeater functionality (not shown)..

[0041] There are two logical groups 141, 142 defined. Similar control command messages can be transmitted to all nodes within a group 141, 142.

[0042] According to examples, the node 135 intends to transmit one or more messages to the luminaires 131-134, e.g., to set a brightness level or to switch on or switch off the luminaires 131-134. To do so, the appropriate message delivery mode is selected. Aspects associated with such selection of the message delivery mode are discussed next in connection with FIG. 2.

[0043] FIG. 2 is a flowchart of a method according to various examples. The method of FIG. 2 can be executed by a node of a wireless communication network of luminaires. For instance, the method of FIG. 2 can be executed by one of the nodes 131-135 of the wireless communication network 130 illustrated in FIG. 1. In some examples, the method can be executed by a control node of the wireless communication network that provides control commands to luminaires. Accordingly, it would be - in particular - possible that the method of FIG. 2 is executed by the control node 135. The method of FIG. 2 can be executed by a processor of such node, upon loading and executing program code from a memory. The processor and the memory form a control circuitry that is configured to execute such method.

[0044] In FIG. 2, optional boxes are illustrated with dashed lines.

[0045] At box 405, it is optionally possible to determine which one or more decision criteria are to be used when later on selecting message delivery modes.

[0046] Different types of decision criteria are conceivable, e.g.: selecting the applicable message delivery mode depending on a number of recipients of a message, e.g., depending on a group size of a logical group of nodes to which the message is to be transmitted; a QoS requirement of the one or more messages to be transmitted; a capability of the wireless communication network and/or individual nodes of the wireless communication network to support certain message delivery modes, e.g., to support multicast message delivery modes.

[0047] Cumulative decision criteria can be determined. A decision criteria hierarchy can be determined, defining a ranking amongst multiple decision criteria, e.g., which decision criterion to check first etc.

[0048] For instance, where the one or more decision criteria are determined, this may be based on a user input received via a user interface. I.e., a user can select certain rules for later on determining how to deliver messages in the wireless communication network. This may be in a deployment phase of the wireless communication network or in a configuration phase.

[0049] In another example, the one or more decision

criteria can be predefined; accordingly, box 405 is optional.

[0050] It is optionally possible - at box 410 - to configure one or more further nodes of the wireless communication network with the one or more decision criteria as determined at box 405. In other words, it is possible to provide to the one or more further nodes a control message that is indicative of the one or more decision criteria. Accordingly, a hyper- parameter for the actual configuration of the message delivery mode is pre-provision to the other nodes; so as to ensure that all nodes or all relevant nodes throughout the wireless communication network apply the same rules that when determining which message delivery mode to use.

[0051] In some scenarios, logical groups are employed for message delivery. In other words, it is possible to define - e.g., based on a user input - multiple logical groups and associate luminaires with these groups.

[0052] At box 415, one or more logical groups are established. Logical groups 141, 142 have been discussed above in connection with FIG. 1. For instance, luminaires assigned to the same logical group can show the same behavior with respect to switching on and switching off or setting the brightness level. It is possible that individual luminaires are assigned to more than a single logical group. Box 415 can be executed in a deployment or configuration phase.

[0053] Logical groups are not required in all scenarios; accordingly, also box 415 is optional.

[0054] In some scenarios, it is then possible, at box 420, to select the message delivery modes for any potential upcoming messages to be delivered to one of message delivery mode responsive to establishment of the logical group. Box 420 may be executed during a deployment or configuration phase. At this point, messages may not have yet arrived at a transmit buffer. Control is not yet "live".

[0055] For instance, it would be possible that for each established logical group at box 415, the respective logical group is instantiated with a default message delivery mode. Only in certain scenarios it may then be required to select specifically a message delivery mode at box 420, e.g., responsive to a user input. For instance, it can be checked whether the wireless communication network and the respective nodes have the capability to support the default message delivery mode; only responsive to determining that either the wireless communication network transmission protocol stack or individual nodes do not support the particular default message delivery mode, it may be required to make a selection at box 420.

[0056] An example scenario of how to select message delivery modes is illustrated in FIG. 3. In the scenario FIG. 3, three message delivery modes 911-913 are defined. The message delivery mode 911 is a low-repetition (a repetition factor of $R=3$ is employed) unicast message delivery mode; the message delivery mode 912 is a low-repetition multicast message delivery mode (e.g., $R=3$); and the message delivery mode 913 is a high-repetition

multicast message delivery mode ($R > 3$; these R-numbers are only examples). The particular message delivery mode is selected from amongst the message delivery modes 911-913 depending on the number of recipients. For illustration, a threshold comparison against multiple thresholds 921, 922 can be made to determine which message delivery mode to select.

[0057] Upon selecting the unicast message delivery mode 911, it would be optionally possible to also define a priority of recipients, i.e., initially transmit instances of a message to the high-priority recipients and only then transmit instances of the messages to the low-priority recipients. This could be based on a round-trip time associated with each recipient. The round-trip time can be probed using dummy messages. By defining a priority, it is possible to enable timely delivery of messages. For example, an instance of a given message may be first transmitted to a high round-trip time recipient (e.g., only reachable via many hops via repeaters); and then a further instance of that message may be transmitted to a low round-trip time recipient. Thereby, from the perspective of the multiple receivers, the instances of the message may arrive with a lower time spread.

[0058] Referring again to FIG. 2: at box 425, other nodes can be optionally configured. For instance, other transmitter nodes possibly transmitting messages can be configured. These nodes can then configure their transmit processes accordingly. Alternatively or additionally, one or more receiver nodes can be configured to configure their receiver processes accordingly.

[0059] Depending on the degree of pre-configuration, box 425 can be implemented differently in different scenarios. For instance, if, at box 410, the one or more decision criteria have already been communicated to the other nodes, it may suffice, at box 425, to inform the other nodes regarding the established logical group of box 415. Then, depending on the particular logical group that has been established and the pre-communicated one or more decision criteria of box 410, the other nodes can locally select the appropriate delivery mode. In another scenario, at box 425, a control message can be provided to the other nodes, the control message being indicative of the selected message delivery mode, e.g., explicitly indicating how to transmit the messages.

[0060] Next, at box 430, a message to be delivered to one or more luminaires of the wireless communication network is obtained. For instance, the message may arrive in a transmit buffer. For instance, the message may arrive at the Network Layer (Layer 3) transmit buffer. Then, it is determined how to transmit the message, based on the pre-selected message delivery mode of box 420. The method is then, at box 435, transmitted to the one or more luminaires in accordance with the selected message delivery mode.

[0061] FIG. 2 is only one example implementation of a method according to the techniques disclosed herein. Variations are conceivable. For instance, instead of selecting the message delivery mode at box 420 responsive

to establishing a respective logical group including one or luminaires, it would be possible that the message delivery mode is selected each time a message to be transmitted is actually obtained, i.e., responsive to box 430. Furthermore, it would be possible to, from time to time, re-evaluate whether the capabilities of one or more luminaires or of the wireless communication network have changed; responsive to detecting a change of one or more capabilities, it would be possible to re-select the message delivery mode. For instance, it can be repeatedly tested whether the capability is available to transmit multicast messages. Responsive to detecting that there is a multicast capability, it would be possible to select a multicast message delivery mode.

[0062] FIG. 4 schematically illustrates a node 80 according to various examples. For instance, the node 80 can implement any one of the nodes 131-135 of the wireless communication network 130 as illustrated in FIG. 1. The node 80 includes a processor 82 and a memory 83. The processor 82 and the memory 83 implement a control circuitry. The processor can receive messages via a communication interface 81 and can transmit messages via the communication interface 81. If the node 80 has lighting functionality, i.e., implements a luminaire, also a light source 84 is provided that is controlled by the processor 82. The processor 82 can load program code from the memory 83 and execute the program code. The processor, upon loading and executing the program code, performs techniques as disclosed herein, e.g., in connection with FIG. 2. The processor, upon loading and executing program code stored in a memory 83, can perform one or more of the following: establish a logical group; select the message delivery mode for each logical group; select between multicast and unicast message delivery for each logical group; select a repetition factor for message delivery; select the priority of luminaires for message transmission in a unicast message delivery mode; etc.

[0063] Summarizing, at least the following EXAMPLES have been disclosed.

EXAMPLE 1. A method of operating a node (80; 131-134; 135) of a wireless communication network (130) of luminaires (80; 131-134), the method comprising:

- for one or more messages to be transmitted to multiple luminaires (80; 131-134) of the wireless communication network (130), selecting (420) a message delivery mode (911, 912, 913) from a plurality of message delivery modes (911, 912, 913) depending on one or more decision criteria, and
- transmitting (435) the one or more messages to the multiple luminaires (80; 131-134) in accordance with the selected message delivery mode (911, 912, 913).

EXAMPLE 2. The method of EXAMPLE 1,

wherein the plurality of message delivery modes (911, 912, 913) comprise a unicast message delivery mode (911) and a multicast message delivery mode (912, 913).

EXAMPLE 3. The method of EXAMPLE 2, further comprising:

- upon selecting the unicast message delivery mode (911): determining a prioritization of transmitting multiple instances of each of the one or more messages to different ones of the multiple luminaires (80; 131-134).

EXAMPLE 4. The method of EXAMPLE 3, wherein the prioritization is determined based on round-trip times between the node (80; 131-134; 135) and each of the multiple luminaires (80; 131-134) in the wireless communication network (130).

EXAMPLE 5. The method of any one of the preceding EXAMPLES, wherein the plurality of message delivery modes comprise a low-repetition message delivery mode (911, 912) and a high-repetition message delivery mode (913).

EXAMPLE 6. The method of any one of the preceding EXAMPLES, wherein the one or more decision criteria comprise a number of recipients of the one or more messages.

EXAMPLE 7. The method of EXAMPLES 2 and 6, wherein the unicast message delivery mode (911) is selected upon the number of recipients of the one or more messages being below a predefined threshold (921, 922).

EXAMPLE 8. The method of EXAMPLES 2 and 6, wherein the multicast message delivery mode (912, 913) is selected upon the number of recipients of the one or more messages being above a predefined threshold (921, 922).

EXAMPLE 9. The method of EXAMPLE 5 and 6, wherein the high-repetition message delivery mode is selected upon the number of recipients of the one or more messages being above a predefined threshold (921, 922).

EXAMPLE 10. The method of any one of EXAMPLES 6 to 9, wherein the number of recipients of the one or more messages is determined depending on a pre-established logical group (141, 142) associated with the multiple luminaires (80; 131-134).

EXAMPLE 11. The method of any one of the preceding EXAMPLES, wherein the one or more decision criteria comprise a quality-of-service requirement of the one or more messages.

EXAMPLE 12. The method of any one of the preceding EXAMPLES, wherein the one or more decision criteria comprise a multicast capability of at least one of a transmission protocol stack of the wireless communication network (130) or each of the multiple luminaires (80; 131-134).

EXAMPLE 13. The method of EXAMPLE 12, further comprising:

- repeatedly testing the multicast capability.

EXAMPLE 14. The method of any one of the preceding EXAMPLES, further comprising:

- providing (410), to one or more further nodes (80; 131-134; 135) of the wireless communication network (130), a control message indicative of the one or more decision criteria.

EXAMPLE 15. The method of any one of the preceding EXAMPLES, further comprising:

- providing (425), to one or more further nodes (80; 131-134; 135) of the wireless communication network (130), a control message indicative of the selected message delivery mode.

EXAMPLE 16. The method of any one of the preceding EXAMPLES,

wherein the multiple luminaires (80; 131-134) form a logical group (141, 142), wherein the message delivery mode is selected responsive to establishment (415) of the logical group (141, 142).

EXAMPLE 17. The method of any one of EXAMPLES 1 to 15, wherein the message delivery mode is selected for each of the one or more messages responsive to the respective one of the one or more messages arriving in a transmit buffer.

EXAMPLE 18. A node (80; 131-134; 135) of a wireless communication network (130) of luminaires (80; 131-134), the node (80; 131-134; 135) comprising control circuitry (81, 83) that is configured to perform the method of any one of the preceding EXAMPLES.

EXAMPLE 19. A computer program comprising pro-

gram code, at least one processor, upon loading and executing the program code, being configured to perform the method of any one of EXAMPLES 1 to 17.

EXAMPLE 20. A method of operating a receiver node (80; 131-134; 135) of a wireless communication network (130) of luminaires (80; 131-134), the method comprising:

- establishing a message delivery mode (911, 912, 913) used by a transmitter node of the wireless communication network (130) for transmitting one or more messages, and
- receiving the one or more messages transmitted by the transmitter node in accordance with the established message delivery mode.

EXAMPLE 21. The method of EXAMPLE 20, wherein said establishing comprises obtaining, from the transmitter node or a control node of the wireless communication network, a control message indicative of one or more decision criteria used by the transmitter node to select the message delivery mode.

EXAMPLE 22. The method of EXAMPLE 20, wherein said establishing comprises obtaining, from the transmitter node or a control node of the wireless communication network, a control message indicative of the message delivery mode.

EXAMPLE 23. A receiver node (80; 131-134; 135) of a wireless communication network (130) of luminaires (80; 131-134), the node (80; 131-134; 135) comprising control circuitry (81, 83) that is configured to perform the method of any one of EXAMPLES 20 to 22.

EXAMPLE 24. A computer program comprising program code, at least one processor, upon loading and executing the program code, being configured to perform the method of any one of EXAMPLES 20 to 22.

[0064] Although the invention has been shown and described with respect to certain preferred embodiments, equivalents and modifications will occur to others skilled in the art upon the reading and understanding of the specification. The present invention includes all such equivalents and modifications and is limited only by the scope of the appended claims.

Claims

1. A method of operating a node (80; 131-134; 135) of a wireless communication network (130) of luminaires (80; 131-134), the method comprising:
 - for one or more messages to be transmitted to

multiple luminaires (80; 131-134) of the wireless communication network (130), selecting (420) a message delivery mode (911, 912, 913) from a plurality of message delivery modes (911, 912, 913) depending on one or more decision criteria, and
 - transmitting (435) the one or more messages to the multiple luminaires (80; 131-134) in accordance with the selected message delivery mode (911, 912, 913).

2. The method of claim 1, wherein the plurality of message delivery modes (911, 912, 913) comprise a unicast message delivery mode (911) and a multicast message delivery mode (912, 913).

3. The method of claim 2, further comprising:

- upon selecting the unicast message delivery mode (911): determining a prioritization of transmitting multiple instances of each of the one or more messages to different ones of the multiple luminaires (80; 131-134).

4. The method of claim 3, wherein the prioritization is determined based on round-trip times between the node (80; 131-134; 135) and each of the multiple luminaires (80; 131-134) in the wireless communication network (130).

5. The method of any one of the preceding claims, wherein the plurality of message delivery modes comprise a low-repetition message delivery mode (911, 912) and a high-repetition message delivery mode (913).

6. The method of any one of the preceding claims, wherein the one or more decision criteria comprise a number of recipients of the one or more messages.

7. The method of claims 2 and 6, wherein the unicast message delivery mode (911) is selected upon the number of recipients of the one or more messages being below a predefined threshold (921, 922).

8. The method of claims 2 and 6, wherein the multicast message delivery mode (912, 913) is selected upon the number of recipients of the one or more messages being above a predefined threshold (921, 922).

9. The method of claims 5 and 6, wherein the high-repetition message delivery mode is selected upon the number of recipients of the one or more messages being above a predefined threshold (921, 922).

old (921, 922).

10. The method of any one of claims 6 to 9,
wherein the number of recipients of the one or more
messages is determined depending on a pre-estab- 5
lished logical group (141, 142) associated with the
multiple luminaires (80; 131-134).
11. The method of any one of the preceding claims,
wherein the one or more decision criteria comprise 10
a quality-of-service requirement of the one or more
messages.
12. The method of any one of the preceding claims,
wherein the one or more decision criteria comprise 15
a multicast capability of at least one of a transmission
protocol stack of the wireless communication net-
work (130) or each of the multiple luminaires (80;
131-134). 20
13. The method of claim 12, further comprising:

- repeatedly testing the multicast capability.
14. The method of any one of the preceding claims, fur- 25
ther comprising:

- providing (425), to one or more further nodes
(80; 131-134; 135) of the wireless communica- 30
tion network (130), a control message indicative
of the selected message delivery mode.
15. The method of any one of the preceding claims,

wherein the multiple luminaires (80; 131-134) 35
form a logical group (141, 142),
wherein the message delivery mode is selected
responsive to establishment (415) of the logical
group (141, 142). 40

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FIG. 1

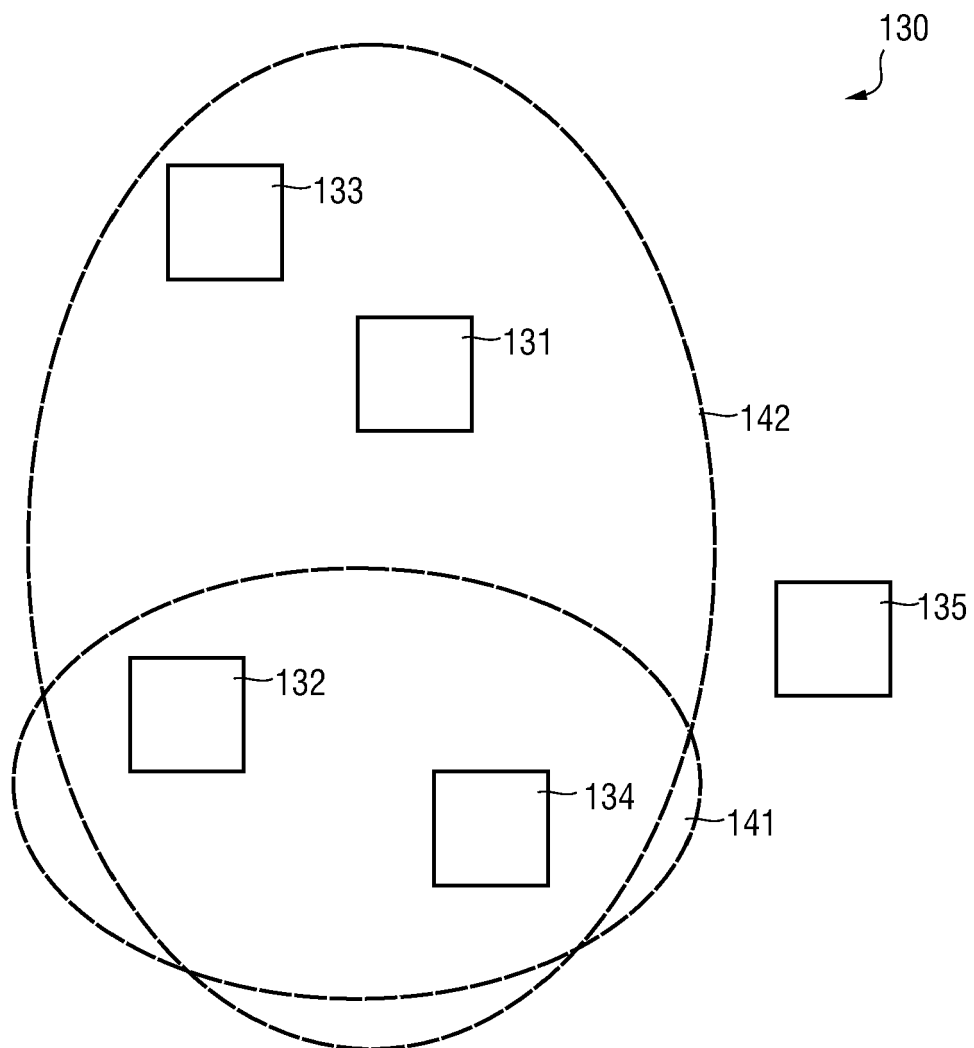


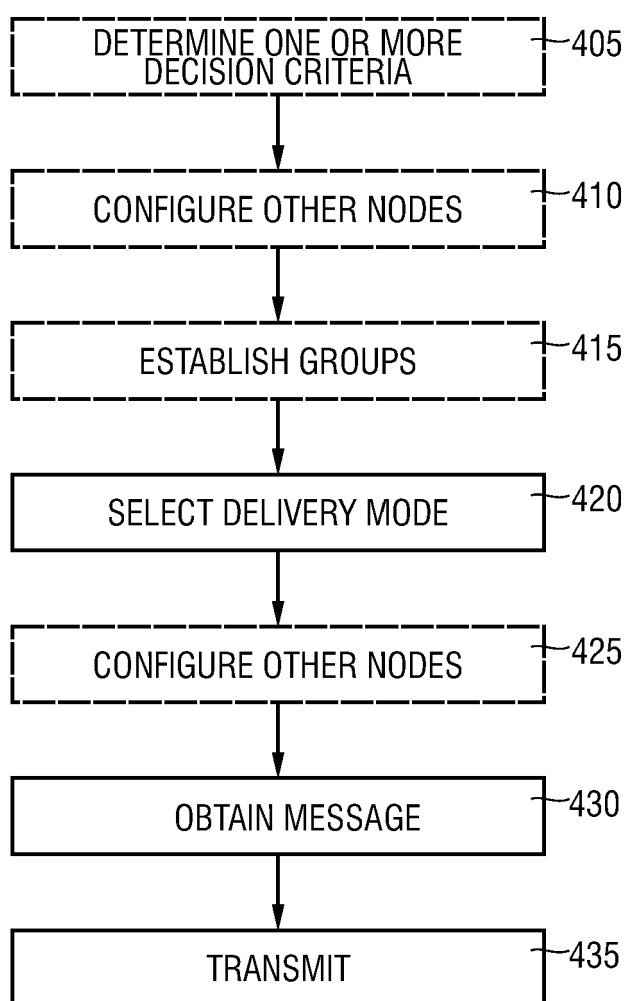
FIG. 2

FIG. 3

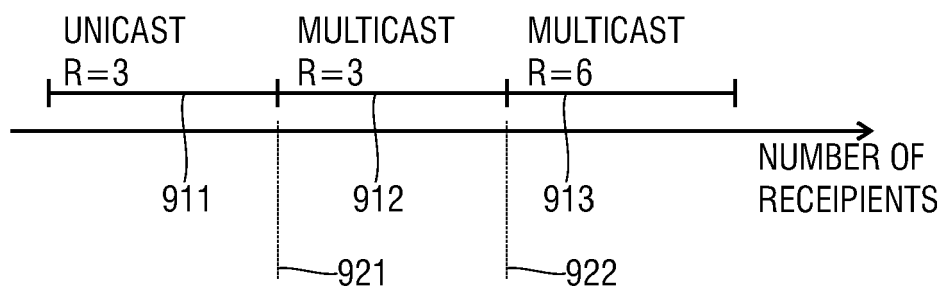
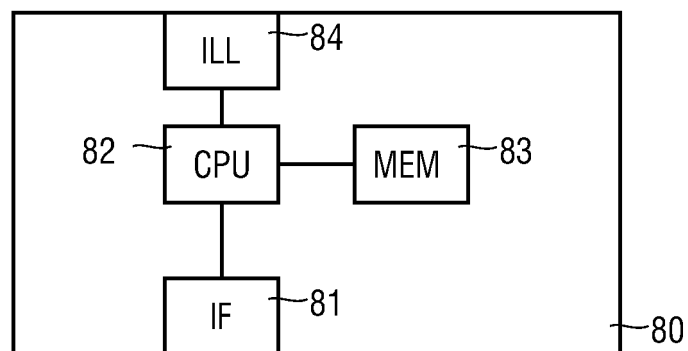


FIG. 4





EUROPEAN SEARCH REPORT

Application Number

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			H05B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 24 August 2023	Examiner Plamann, Tobias
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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