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(54) Title: METHOD FOR COMMUNICATIONS RELIABILITY ENHANCEMENTS WITH ACCESS ENTITY ASSISTANCE

(57) Abstract: An example technique may include a method executed by a user device in communication with an access entity where the user device generates a message, determines a distance to a target destination of the message, determines a direction of the target destination of the message, determines a range of transmission, the range of transmission being based on a proportion of the distance to the target destination, determines time-to-live (TTL) of the message based on message classification and communicates the message based on the range of transmission and the TTL, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

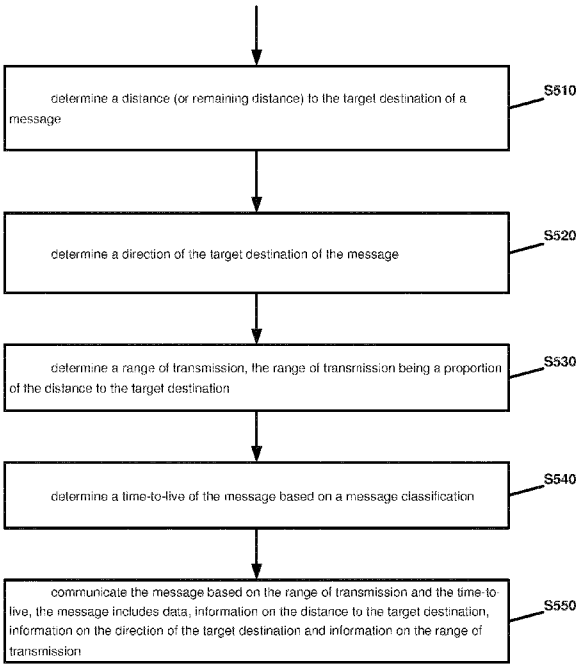


FIG. 5

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DESCRIPTION

TITLE

METHOD FOR COMMUNICATIONS RELIABILITY ENHANCEMENTS WITH ACCESS ENTITY ASSISTANCE

TECHNICAL FIELD

[0001] This description relates to communications.

BACKGROUND

[0002] A communication system may be a facility that enables communication between two or more nodes or devices, such as fixed or mobile communication devices. Signals can be carried on wired or wireless carriers.

[0003] Standardization committees or bodies develop cellular communication system architectures for use in, for example, device to device communication (D2D) communications. For example, the Third Generation Partnership Project (3GPP) is an industry body set up to develop a 3G standard. Other industry bodies (e.g., ITU Radio Communications Sector (ITU-R) and ITU-Telecommunications (ITU-T) groups) are involved with advances toward 4G (e.g., support for data rates up to100 Mbps) and 5G (e.g., support for a world wide wireless web that is capable of supporting wireless based web applications that includes full graphics and multimedia capability at beyond 4G speeds) system architectures.

[0004] An example of a cellular communication system is a 3G architecture standardized by 3GPP which is often referred to as the long-term evolution (LTE) of the Universal Mobile Telecommunications System (UMTS) radio-access technology. E-UTRA (evolved UMTS Terrestrial Radio Access) is the air interface of 3GPP's Long Term Evolution (LTE) upgrade path for mobile networks. In LTE, base stations, which are referred to as enhanced Node Bs (eNBs), provide wireless access within a coverage area or cell. In LTE, mobile devices, or mobile stations are referred to as user equipments (UE).

SUMMARY

[0005] According to an example implementation, a method may include generating (or control generating) a message by a user device in communication with an access entity, determining (or control determining) a distance to a target destination of the

message, determining (or control determining) a direction of the target destination of the message, determining (or control determining) a range of transmission, the range of transmission being based on a proportion of the distance to the target destination, determining (or control determining) time-to-live (TTL) of the message based on message classification, determining (or control determining) at least one destination based on the range of transmission and the TTL, and communicating (or control communicating) the message to the at least one destination, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

[0006] According to another example implementation, an apparatus may include at least one memory including computer instructions, when executed by the at least one processor, cause the apparatus to generate (or control generating) a message by a user device in communication with an access entity, determine (or control determining) a distance to a target destination of the message, determine (or control determining) a direction of the target destination of the message, determine (or control determining) a range of transmission, the range of transmission being based on a proportion of the distance to the target destination, determine (or control determining) time-to-live (TTL) of the message based on message classification, determine (or control determining) at least one destination based on the range of transmission and the TTL, and communicate (or control communicating) the message to the at least one destination, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

[0007] According to still another example implementation, an computer program product may include a computer-readable (or non-transitory computer-readable) storage medium and storing executable code that, when executed by at least one data processing apparatus, is configured to cause the at least one data processing apparatus to perform a method that includes generating (or control generating) a message by a user device in communication with an access entity, determining (or control determining) a distance to a target destination of the message, determining (or control determining) a direction of the target destination of the message, determining (or control determining) a range of transmission, the range of transmission being based on a proportion of the distance to the target destination, determining (or control determining) time-to-live (TTL) of the message based on message classification, determining (or control determining) at least one destination based on the range of transmission and the TTL, and communicating (or control communicating) the message to the at least one destination, the message including information based on the distance to the target destination, information based on

the direction of the target destination and information based on the range of transmission.

[0008] According to still another example implementation, an apparatus may include means for generating a message by a user device in communication with an access entity, means for determining a distance to a target destination of the message, means for determining a direction of the target destination of the message, means for determining a range of transmission, the range of transmission being based on a proportion of the distance to the target destination, means for determining time-to-live (TTL) of the message based on message classification, and means for communicating the message based on the range of transmission and the TTL, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

[0009] Implementations can include one or more of the following features. For example, the method can further include determining (or control determining) at least one intermediate destination, wherein the controlling of the communicating of the message includes controlling the communicating of the message to the at least one intermediate destination. The method can include determining (or control determining) the range of transmission to include one or more hops. The at least one message type can be addressed to at least one other user device that is not in close proximity to the user device. The message can further include a message classification based on at least one of a message priority, a message type, a service type, a location, a type of user device. The message can further include geographical coordinates of at least one of an incident, the user device and the target destination. The geographical coordinates can be generated based on Global Positioning System (GPS) coordinates of a message source.

[0010] For example, the method of can further include determining (or control determining) the direction of the target destination is based on information obtained from at least one of a traffic safety sensor, a local road map and other traffic information systems. The obtained information can be a compound value that defines one of a single value, two values or a field indicating multiple values. The method can further include determining (or control determining) a priority of the message. The parameters related to over-the-air transmission of the message can be adjusted based on the priority of the message. The message may further include information associated with a TTL of an earlier in time message. The TTL can have an indefinite value indicating the message is to be broadcasted until stopped using a special control signal. The range of transmission and the distance to the target destination can be weighted based on a density and speed of traffic. The TTL can be weighted based on the density and speed of traffic. The method of can further include compensating (or control compensating) for the road

distance upon determining a road distance between two access entities is greater than a Euclidean distance between the two access entities.

[0011] According to an example implementation, a method may include receiving (or control receiving) a message by an access entity communicatively coupled to a plurality of other access entities. The message includes data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and the range of transmission is a proportion of the distance to the target destination. Upon receiving the message, the access entity determines (or controls determining) if the access entity is in the direction of the target destination, upon determining the access entity is not in the direction of the target destination, the access entity discards (or controls discarding) the message, and upon determining the access entity is in the direction of the target destination, the message is forwarded, by the access entity, by at least one of controlling transmitting the message to at least one of the plurality of other access entities or controlling broadcasting at least a portion of the message.

[0012] According to another example implementation, an apparatus includes at least one processor and at least one memory including computer instructions, when executed by the at least one processor, cause the apparatus to receive (or control receiving) a message by an access entity communicatively coupled to a plurality of other access entities. The message includes data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and the range of transmission is a proportion of the distance to the target destination. Upon receiving the message, the access entity determines (or controls determining) if the access entity is in the direction of the target destination, upon determining the access entity is not in the direction of the target destination, the access entity discards (or controls discarding) the message, and upon determining the access entity is in the direction of the target destination, the message is forwarded, by the access entity, by at least one of controlling transmitting the message to at least one of the plurality of other access entities or controlling broadcasting at least a portion of the message.

[0013] According to still another example implementation, an computer program product may include a computer-readable (or non-transitory computer-readable) storage medium and storing executable code that, when executed by at least one data processing apparatus, is configured to cause the at least one data processing apparatus to perform a method that includes receiving (or control receiving) a message by an access entity communicatively coupled to a plurality of other access entities. The message includes

data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and the range of transmission is a proportion of the distance to the target destination. Upon receiving the message, the access entity determines (or controls determining) if the access entity is in the direction of the target destination, upon determining the access entity is not in the direction of the target destination, the access entity discards (or controls discarding) the message, and upon determining the access entity is in the direction of the target destination, the message is forwarded, by the access entity, by at least one of controlling transmitting the message to at least one of the plurality of other access entities or controlling broadcasting at least a portion of the message.

[0014] According to still another example implementation, an apparatus may include means for receiving a message by an access entity communicatively coupled to a plurality of other access entities. The message includes data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and the range of transmission is a proportion of the distance to the target destination. Upon receiving the message, means for determining if the access entity is in the direction of the target destination, upon determining the access entity is not in the direction of the target destination, means for discarding the message, and upon determining the access entity is in the direction of the target destination, means for forwarding the message by at least one of transmitting the message to at least one of the plurality of other access entities or broadcasting at least a portion of the message.

[0015] Implementations can include one or more of the following features. For example, the message can be one of a broadcasted message or a transmitted message. The method can further include re-determining (or control re-determining), by the access entity, the range of transmission prior to forwarding the message. The method can further include re-determining (or control re-determining), by the access entity, the distance to the target destination upon determining the target destination is a moving target prior to forwarding the message. The method can further include re-determining (or control re-determining), by the access entity, the direction of the target destination prior to forwarding the message. The method can further include comparing (or control comparing), by the access entity, the range of transmission with a distance to at least one of the plurality of other access entities by which the message received, comparing (or control comparing), by the access entity, the distance to the target destination with the distance to the at least one of the plurality of other access entities by which the message is to be transmitted, and upon determining the distance to the at least one of the plurality of other access entities by

which the message is to be transmitted is not shorter than the range of transmission and is shorter than the distance to the target destination, the forwarding can be carried out by transmitting (or controlling transmitting) to at least one of the plurality of other access entities and broadcasting (or controlling broadcasting).

[0016] For example, the method can further include comparing (or control comparing), by the access entity, the range of transmission with a distance to at least one of the plurality of other access entities by which the message received, comparing (or control comparing), by the access entity, the distance to the target destination with the distance to the at least one of the plurality of other access entities by which the message is to be transmitted, and upon determining the distance to the at least one of the plurality of other access entities by which the message is to be transmitted and the range of transmission is shorter than the distance to the target destination, the forwarding can be carried out by transmitting (or controlling transmitting) to the at least one of the plurality of other access entities. The message can include information on TTL, and the forwarding can be carried out in a time period of the TTL. The method can further include upon determining a road distance between two access entities is greater than a Euclidean distance between the two access entities, compensating (or control compensating) for the road distance.

[0017] The details of one or more examples of implementations are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a block diagram of a wireless network according to an example implementation.

[0019] FIG. 2 is another block diagram of a wireless network according to an example implementation.

[0020] FIG. 3 is a block diagram illustrating a communication of a message in the context of the wireless network of FIG. 2 according to an example implementation.

[0021] FIG. 4 is a flow diagram illustrating a technique for communicating a message according to at least one example implementation.

[0022] FIGS. 5 and 6 are flow charts illustrating operation of a node according to at least one example implementation.

[0023] FIG. 7 is a block diagram of a wireless station (e.g., node, BS or user device) according to an example implementation.

[0024] FIG. 8 is a block diagram of nodes installed along a very curvy road according to at least one example implementation.

DETAILED DESCRIPTION

[0025] FIG. 1 is a block diagram of a wireless network 130 according to an example implementation. In the wireless network 130 of FIG. 1, user devices 131, 132, 133 and 135, which may also be referred to as user equipments (UEs), may be connected (and in communication) with a base station (BS) 134, which may also be referred to as an enhanced Node B (eNB). At least part of the functionalities of a base station or (e)Node B (eNB) may be also be carried out by any node, server or host which may be operably coupled to a transceiver, such as a remote radio head. BS 134 provides wireless coverage within a cell 136, including to user devices 131, 132, 133 and 135. Although only four user devices are shown as being connected or attached to BS 134, any number of user devices may be provided. BS 134 is also connected to a core network 150 via a S1 interface 151. This is merely one simple example of a wireless network, and others may be used. Example embodiments may be implemented in, for example, a 5G wireless networks in which other nomenclature may be utilized to describe similar elements as described with regard to FIG. 1 and throughout this disclosure.

[0026] A user device (user terminal, user equipment (UE), mobile device) may refer to a portable computing device that includes wireless mobile communication devices operating with or without a subscriber identification module (SIM), including, but not limited to, the following types of devices: an integrated in-vehicle communications and entertainment system, a mobile station, a mobile phone, a cell phone, a smartphone, a personal digital assistant (PDA), a handset, a device using a wireless modem (alarm or measurement device, etc.), a laptop and/or touch screen computer, a tablet, a phablet, a game console, a notebook, and a multimedia device, as examples. It should be appreciated that a user device may also be a nearly exclusive uplink only device, of which an example is a camera or video camera loading images or video clips to a network.

[0027] In LTE (as an example), core network 150 may be referred to as Evolved Packet Core (EPC), which may include a mobility management entity (MME) which may handle or assist with mobility/handover of user devices between BSs, one or more gateways that may forward data and control signals between the BSs and packet data networks or the Internet, and other control functions or blocks.

[0028] An example implementation of Device-To-Device (D2D) in the context of Machine Type Communication (MTC) is V2X communications. V2X communications includes Vehicle-to-Vehicle (V2V) communication and Vehicle-to-Infrastructure (V2I)

communication. V2V is an example implementation of D2D which addresses the area of Ultra Reliable Communication (URC) from requirements point of view in wireless (e.g., 5G) systems. In LTE D2D usage is assumed opportunistic. However, example implementations of 5G D2D can include broader applications. For example, 5G D2D may achieve higher reliability and lower latency as compared to LTE D2D. V2I includes communication that further allow highway infrastructure (e.g., traffic signals) to communicate directly with motor vehicles. V2I communications can further address safety applications designed to avoid or mitigate vehicle crashes. In addition, V2I can be implemented in a driverless car application (e.g., to control the position of a motor vehicle within a highway lane).

[0029] In, for example, 5G wireless networks, architectures similar to the wireless network 130 may be implemented in urban or highly populated areas. However, outside of urban areas (e.g., sub-urban, rural and/or sparsely populated) a small (micro, pico) cell architecture may be used (e.g., for V2X, V2V and/or V2I communications). For example, an access entity may be an apparatus configured to communication with a user device, other access entities and/or network architecture in wireless network architectures (e.g., a 5G architecture). In some example implementations, an access entity may be configured to wirelessly communicate with a user device. In some example implementations, an access entity may be configured to wired and/or wirelessly communicate with other access entities and/or network architecture. An access entity may be, for example, a road side unit (RSU), a base station, a relay, a self-backhauled node, an eNB, a NB, a remote radio head, an access point such as a wifi access point and vehicle or an apparatus in the vehicle utilizing the general antenna system of the vehicle.

[0030] A node (e.g., eNB or BS) can provide the transport network connectivity for other nodes utilizing a radio connection via the other nodes. This method is called “self-backhauling” because the radio link itself can be additionally used (e.g., in addition to user device communications) as a transport link for some of the nodes or access entities. In a system employing self-backhauling, a node that is connected to the network via a radio connection is referred to as self-backhauled node. Accordingly, the access entity or RSU may also be referred to as a self-backhauling node. The node can also provide connectivity via wired link to the network or other nodes e.g., in case of eNB or BS. Such a access entity may also be referred to as an RSU.

[0031] FIG. 2 is another block diagram of a wireless network 200 according to an example implementation. As shown in FIG. 2, the wireless network 200 includes a plurality of access entities 205-1, 205-2, 205-3, 205-n. Each of the plurality of access entities 205-1, 205-2, 205-3, 205-n may be communicatively coupled to an anchor node

(illustrated as BS 134) via a corresponding interface 210-1, 210-2, 210-3, 210-n. Accordingly, each of the plurality of access entities 205-1, 205-2, 205-3, 205-n may be referred to as a self-backhauled node. Interface 210-1, 210-2, 210-3, 210-n may be wired and/or wireless. In example implementations including V2X, V2V and/or V2I communication (e.g., for highways along sparsely populated areas), the back-end of wireless communications can be facilitated through the use of wide area macro cells configured to communicate with existing network infrastructure (e.g., core network 150). Accordingly, an anchor node (illustrated as BS 134) can be associated with and/or referred to as a wide area macro cell.

[0032] The plurality of access entities 205-1, 205-2, 205-3, 205-n may be communicatively coupled via a corresponding interface 225-1, 225-2, 225-n. Accordingly, access entity 205-1 may be configured to communicate (or directly communicate) with access entity 205-2 via interface 225-1, access entity 205-2 may be configured to communicate (or directly communicate) with access entity 205-3 via interface 225-2 and access entity 205-3 may be configured to communicate (or directly communicate) with access entity 205-n via interface 225-n (and so forth). Interface 225-1, 225-2 and 225-n may be wired and/or wireless interfaces.

[0033] In an example implementation, interface 225-1, 225-2, 225-n can be wired. In this case, each of the plurality of access entities 205-1, 205-2, 205-3, 205-n can represent an individual small cell. In an example implementation, interface 225-1, 225-2, 225-n can be wireless. In this case, each of the plurality of access entities 205-1, 205-2, 205-3, 205-n can be connected to a donor cell (e.g., the wireless network 130 of FIG. 1) via a wireless backhaul (e.g., interface 210-1, 210-2, 210-3, 210-n). In this case, each of the plurality of access entities 205-1, 205-2, 205-3, 205-n may or may not act as independent cells from RRM perspective. In both example implementations, the plurality of access entities 205-1, 205-2, 205-3, 205-n can communicate with each other via, for example, a direct interface (wired or wireless), or through a logical interface (via donor cell). A direct interface may be desirable because a logical interface may incur additional delays from a V2X, V2V and/or V2I latency perspective.

[0034] A plurality of vehicles 215-1, 215-2, 215-3, 215-n (e.g., forming a V2X, V2V and/or V2I network) may be communicatively coupled with the plurality of access entities 205-1, 205-2, 205-3, 205-n over a wireless interface 220-1, 220-2, 220-3, 220-n. The plurality of vehicles 215-1, 215-2, 215-3, 215-n may include a user device (described above) and/or include an integrated in-vehicle communications and entertainment system configured to operate in a V2X, V2V and/or V2I network. In other words, the plurality of vehicles 215-1, 215-2, 215-3, 215-n may be configured to operate in a (D2D) mode in

which the plurality of vehicles 215-1, 215-2, 215-3, 215-n may directly communicate with each other using a V2X, V2V and/or V2I network as implemented using, for example, an integrated in-vehicle communications and entertainment system. The plurality of vehicles 215-1, 215-2, 215-3, 215-n may travel in any number of directions. For example, vehicles 215-1, and 215-3 are illustrated as travelling in a first direction, while vehicles 215-2, and 215-n are illustrated as travelling in a second direction.

[0035] In example implementations, different types of messages can be sent in the context of vehicular communication that can have varying communication range and delay requirements. For example, an on-road collision warning and brake alert mechanism can have more critical range requirements (e.g., in the order of tens of meters to hundreds of meters) for high or very high speed scenarios. For example, high range communications such as reporting road closures, toll collection, diversions, reporting points of interest (service station, ATM, restaurants, and/or the like) can have a range of communication, for example, between hundreds of meters to few kilometers. However, an associated latency requirement can be lower (as compared to an on-road collision warning) and the reliability requirement can be less strict. Other V2X, V2V and/or V2I applications such as lane merge assistance, warning of an accident ahead, ERV alerts, weather alerts (such as slippery road ahead due to snow, and/or the like), approaching pedestrian crossing, change in speed limits, speed breaker ahead, animal crossing etc. may have range requirements somewhere in between low range and high range messages.

[0036] The range requirements may not be fixed and can depend on the local conditions such as speed of vehicles, number of vehicles, type of the road (urban, rural, motorway), severity of the information and even vehicle preferences among others. Moreover, the range can not only variable but can also change dynamically. Additionally, geographical factors may play a role in the range. For example, a mountain road with several tight curves may imply a different information range as compared to a “line-of – sight”, straight highway. Reporting these varying sets of information accurately within an intended communication range can be difficult. For example, in the case of infrastructure support (e.g., a wide area macro cell), such messages can be broadcasted within an entire cell. However, the more messages (and the more cars/devices), the more radio spectrum resources will be the required. Another way to deal with these challenges can be to use vehicles to route such information to each other. However, this technique may not be robust due to varying density of road traffic.

[0037] Traditionally, network content is distributed in the form of unicast (one transmitter to another receiver), multicast (one transmitter to many known receivers) or broadcast (one transmitter to many unknown receivers). In the context of V2X, V2V

and/or V2I, the geographic range of information distribution is more vital than the identity of actual receivers. Example embodiments can solve or reduce limitations associated with range in a vehicular scenario.

[0038] Accordingly, in example implementations, content can be distributed to and from user devices (e.g., vehicles) where the parameters described by the content such as distribution range, lifetime, priority and/or the like, coupled with local conditions such as geometry of the path (e.g., a topology and type of the road in V2X, V2V and/or V2I context) and the user device distribution (e.g., vehicle traffic) dynamically help determine the network address of the geographical area where the content should be distributed. Example implementations can be extended to a vehicular scenario with access entities (e.g., the plurality of access entities 205-1, 205-2, 205-3, 205-n). In example implementations, the access entities can take three roles.

[0039] First, a forwarding role. The forwarding role can be to relay a UE/MTC-Vehicle originating message according to the message priority, life-time and range etc. This relaying could mean that a given message may be forwarded to the next access entity and/or broadcasted in the current one, or that the receiving access entity may just broadcast the received message to other user devices/Vehicles connected to it.

[0040] Second, a forward and broadcast role. The forward and broadcast role can be to include a range profile in the message header which would enable access entities to make a decision on how far a given message shall be propagated along a given road. Moreover, the message header also helps determine a set of receiving access entities which would broadcast the message to the vehicles under their coverage. This may require that the network/access entity are equipped with some “intelligence” because there may be several factors determining the distance and time-to-live for those messages. This may be impacted, for example, by the current traffic conditions (e.g., a given message may be propagated further if the road is empty) weighted with a given road type (e.g., a broader propagation area can be used along highway where cars tend to move at very high speeds as compared to a rural area). Further, a priority/severity of a message may impactful, along with average vehicle speed, weather conditions, and/or the like.

[0041] Third, a broadcast role. The broadcast role can be to receive a UE/MTC-Vehicle originating message according to the message priority, life-time and range etc. and to broadcast (without relaying) the message to the vehicles under their coverage.

[0042] In example implementations, an initial setup may be performed where different access entities (e.g., the plurality of access entities 205-1, 205-2, 205-3, 205-n)

may communicate with each other to obtain an estimate of separation distance between them. This estimate can be determined dynamically. For example, the estimate of separation distance can be determined using measures such as round trip time (RTT), pathloss measurements, geographic (e.g., GPS) coordinates and/or the like. Alternatively, or in addition, the estimate of separation distance can be pre-programmed during a deployment phase. The initial setup can establish a measure of distance between access entities and their immediate neighbors. If the system has more intelligence apart from the direct distance between access entities the estimate of separation distance can be established by the distance on a given road that is covered by the access entity (this may be different in case of very curvy roads). This can be accomplished by, for example, using road maps and geographic (e.g., GPS) coordinates.

[0043] FIG. 3 is a block diagram illustrating a communication of a message in the context of the wireless network of FIG. 2 according to an example implementation. As discussed above, in addition to distance information, the message may include other information (e.g., priority, time-to-live and/or the like). As shown in FIG. 3, vehicle 215-1 is a distance A from access entity 205-1, access entity 205-2 is a distance B from access entity 205-1 and access entity 205-3 is a distance C from access entity 205-2. Accordingly, vehicle 215-1 is a distance A+B from access entity 205-2 and a distance A+B+C from access entity215-3. According to an example implementation, vehicle 215-1 may generate a message. The message may include data associated with, for example, a warning of an accident ahead. The message may be relevant to vehicles travelling in one direction (e.g., the first direction associated with vehicles 215-1 and 215-3 or the second direction associated with vehicles 215-2 and 215-n) or may be relevant to vehicles travelling in any direction (e.g., both the first direction associated with vehicles 215-1 and 215-3 and the second direction associated with vehicles 215-2 and 215-n). The message may be relevant to vehicles within a range of an incident (e.g., a warning of an accident ahead) or information (e.g., a road closing or gas station). This range can be associated with a minimum range and a maximum range as shown in FIG. 3.

[0044] In an example implementation, the minimum range may indicate a target (or next) access entity and the maximum range may indicate a destination (or last access entity). Further, the minimum range and the maximum range may include a plurality of destinations (e.g., destination access entities or RSUs). Destinations may refer to a first, an intermediate and/or last destination defined by the minimum range and the maximum range. The first destination can be the one satisfying the minimum range and the last destination can be the one defined by maximum range. The intermediate destinations can be any destination in between first destination and last destination.

[0045] The message can be configured for communication to other user devices (e.g., vehicles). The message can be a fixed message or a dynamic message. For example, a fixed message can be a message that originates from fixed or non-mobile sources (e.g. roadworks, intersection, traffic diversion, and/or the like). In example implementations, the fixed message may originate from the access entity itself, a user device connected to the access entity and/or traffic safety sensors. The source can be static (e.g., non-moving) over a period of time. Therefore, the access entity can be connected to the user device (either direct connection similar to RRC_CONNECTED in LTE or the user device could be idle on the best available access entity similar to RRC_IDLE in LTE).

[0046] For example, a dynamic message can be a message that originates from a mobile source (such as a moving car). In example implementations, each vehicle can establish a connection to the nearest access entity based on signal quality measurements where the nearest access entity can be the access entity with strongest signal. This could potentially include other connectionless methods as well in which case nearest access entity would be one or more depending on whichever can receive the originating message with the best quality. The message itself can be transmitted on static or semi-static resources allocated by the network.

[0047] Each message can contain an embedded communication range field. For example, the communication range field can be included in a header of the message. The communication range field may include several values. For example, the values may include minimum and maximum reporting range from the source location, priority, time-to-live (TTL), cause and/or the like.

[0048] The minimum and maximum reporting range can be used to determine the target geo-location of the message. The minimum range can determine the starting point of the message distribution while the maximum field can be the finish point. access entities within this range can broadcast the message to user devices (e.g., vehicles). Different type of messages can have different range profiles. The messages can be classified as access entity originated fixed messages. For example, messages reporting points of interest or other stationary objects such as speed breakers can be programmed into access entities with the possibility to reprogram and dynamically change their intended communication range. The messages can be classified as access entity originated dynamic messages. For example, these messages may not be programmed into access entities but can be obtained through other sources such as manual entries, sensors etc. Examples can include messages reporting weather hazards, road blocks, accidents etc. Similar to the above case, these messages can have fixed or dynamic

reporting range fields. The messages can be classified as vehicle originated dynamic messages. For example, these messages can originate from vehicles themselves and may be intended for trailing or approaching vehicles. Vehicle originated dynamic messages can have fixed or dynamic range fields similar to above depending on the nature of the message. Examples include lane merging, lane change assistance, overtaking and/or the like.

[0049] TTL may indicate the update frequency and the duration for which the message is broadcasted to the vehicles in coverage. TTL may also indicate a time period over which the message should be communicated (e.g., to other access entities). TTL can indicate how long the message is propagated and/or broadcasted. An immediate hazard may only have short lifespan (few seconds) with its express goal to warn the vehicles x meters away. A roadblock or diversion may have an indefinite TTL.

[0050] Priority can be used to determine how critical the transmitted information is. Priority may also indicate how V2X, V2V and/or V2I messages are classified. For example, a message that carries information about a potential accident is more critical (and, thus, may have a higher priority) than a message including information about roadblocks. Priority can impact how drivers or vehicles are expected to respond to the message and/or how the destination access entity(s) broadcast the message. For example, a message with high priority can be required to be more robust in terms of modulation, coding, transmit power and/or the like.

[0051] As an example, vehicle 215-1 may generate a message. In addition to other relevant information (e.g., data indicating what caused the generation of the message), the message may include a communication range and a time-to-live (TTL). For example, the message may include information indicating a minimum range of A+B, a maximum range of A+B+C, a direction (e.g., indicating the first direction associated with vehicles 215-1 and 215-3) and a TTL of, for example, one (1) second, one (1) minute or one (1) hour.

[0052] Vehicle 215-1 may communicate the message to access entity 205-1. If access entity 205-1 is within the communication range, access entity 205-1 may then broadcast the message (information associated with and/or a portion thereof) to other user devices (e.g., vehicles) within range of access entity 205-1. Accordingly, a access entity may be configured to determine if the access entity is within the communication range. For example, an access entity may be configured to determine its position (e.g., as compared to another access entity and/or geographic coordinates) and compare the access entities position to the communication range. Further, access entity 205-1 may determine that the message (or a modification thereof) should be communicated to access

entity 205-2 based on, for example, the min range, the max range and the direction. In an example implementation, the min range may indicate a target (or next) access entity and the max range may indicate a destination (or final access entity). access entity 205-1 may modify the message to change, for example, the min range and the max range. For example, access entity 205-1 may change the min range to B and the max range to B+C.

[0053] Upon receiving the message, and if access entity 205-2 is within the communication range, access entity 205-2 may broadcast the message (information associated with and/or a portion thereof) to other user devices (e.g., vehicles) within range of access entity 205-2. Further, access entity 205-2 may determine that the message (or a modification thereof) should be communicated to access entity 205-3 based on, for example, the min range, the max range and the direction. access entity 205-2 may modify the message to change, for example, the min range and the max range. For example, access entity 205-2 may change the min range to zero (0) or approximately zero and the max range to C.

[0054] Upon receiving the message, and if access entity 205-3 is within the communication range, access entity 205-3 may broadcast the message (information associated with and/or a portion thereof) to other user devices (e.g., vehicles) within range of access entity 205-3. Further, access entity 205-3 may determine that the message should not be further communicated because the message has reached its maximum range. access entity 205-1, 205-2 and 205-3 may broadcast the message (information associated with and/or a portion thereof) to other user devices (e.g., vehicles) for a period of times and/or a number of times based on TTL. For example, access entity 205-1, 205-2 and 205-3 may broadcast the message to other user devices for an hour, until a fixed time (e.g., 3 pm) and/or a number of times (e.g., 1 per minute or 30 times) based on the TTL.

[0055] Message routing to the intended destination can be achieved using one of two techniques. In a first technique, a message can be routed using pre-calculated range-to-destination translation. In this example implementation, access entities can store (e.g., in a memory of the access entity) and/or be configured to determine a distance to neighboring access entity(s) up to several hops and can accurately identify the destination access entity. The communication range can have multiple values (maximum and minimum, priority, cause, time-to-live). Therefore, the destination access entity can include one or more access entities. Using this technique, the originator access entity can be configured to decode the distance field and compute the destination access entity (s) based on the pre-configured distance. The message can be routed via at least one access entity assisted hops to the destination or if the range is far away enough based on

a set threshold, it is routed via the nearby macro cell. The latter case of routing is applicable to large distance (in the order to several hundred meters to few kilometers) and can be subject to the availability of macro cells.

[0056] In an example implementation, a message can be routed using destination access entity (s) which may be computed directly by decoding the minimum and maximum reporting range of the message as explained above. The distance between two access entities can be pre-configured in the deployment phase of an access entity based on, for example, geographic coordinates (e.g., GPS), radio measurements, road topology and/or the like. Road topology can be relevant in scenarios where roads are bendy and curvy. For example, two access entities can be 10 meters apart geographically but due to a bend in the road, the effective distance can be longer.

[0057] For example, as illustrated in FIG. 8, a plurality of access entities 205 can be installed along a very curvy road. Due to geographical conditions the road requires several sharp turns and hence a message originated at a first user device (e.g., vehicle 205-1) can be propagated to a second user device (e.g., vehicle 205-2) since there might not be enough visibility. FIG. 8 also illustrates a case where Euclidean distance measured through RTT or pathloss may not be accurate due to non linear road and may require local maps and GPS coordinates to compute the effective distance between access entities 205. Accordingly, in example implementation may include compensating (e.g., adding) for the road distance between two access entities if road distance is greater then the Euclidean distance (e.g., due to curved roads).

[0058] In a second technique (of message routing), a message can be routed using dynamic range-to-destination translation. In this example implementation, access entities can be either configured to determine (e.g., store in memory) the distance of the access entities immediate neighbor access entity or can be configured to compute the distance from the next nearest access entity upon receiving the message using pathloss, RTT or other measures (less practical solution). In such cases, the message can be forwarded to the next hop (next access entity in this case). The originator hop can modify the range fields in the message header such that it subtracts the distance between itself and the next hop before forwarding it to the next hop. The process repeats itself and the distance is decremented on each hop until the destination access entity (s) is(are) reached. In another implementation, instead of decrementing the range fields from the message header, each recipient hop can add the distance travelled on each hop.

[0059] In an example implementation, the distance between two Access entities is known, the interface between access entities (either direct or logical interface via network) is responsible for forwarding the message. As an example, access entities can be 100

meters apart. The distance fields in the message is defined as 500(min) and 700(max). If the message is propagated using direct wireless interface between the access entities, then on each hop, the receiving access entity can decode the header and subtract the corresponding distance travelled by the message (100m in this example) until equaling a range of 0(min) and 200(max). A range of 0(min) and 200(max) would indicate that the receiving access entity needs to forward the message to the next access entity (and the one after) while simultaneously broadcasting it to the vehicles in its vicinity. Accordingly, the message can be propagated to all (or a substantial amount of) the vehicles in 200 meters range at a distance of 500 meters from the source. In an example implementation where there is an absence of a direct interface, the network may compute the target access entity (s) and directly forward the message to the target access entity (s).

[0060] FIG. 4 is a flow diagram illustrating a technique for communicating a message according to at least one example implementation. As shown in FIG. 4, vehicle 215-1 generates a first message (402). The message includes destination information. For example, the destination information may include a minimum range, a maximum range and a direction. The destination information may be included in a header of the message. The first message is then communicated to access entity 205-1 (404). Upon receiving the first message, access entity 205-1 determines whether access entity 205-1 is located within the destination (e.g., within the minimum range and the maximum range) and if so, broadcasts (406) information associated with the first message (e.g., a traffic condition) to other user devices (e.g., vehicles) within range of access entity 205-1. access entity 205-1 then determines if the message has reached the end of its range (408). For example, access entity 205-1 may compare the maximum range associated with the message with a distance of access entity 205-1 from vehicle 215-1. If the message has not reached the end of its range, a second message is generated (410) based on the first message. For example, the second message may be the same as the first message with the exception of the destination information. For example, the minimum range and the maximum range of the second message may be different (e.g., less than) than the minimum range and the maximum range of the first message. The second message is then communicated to access entity 205-2 (412).

[0061] Upon receiving the first message, access entity 205-2 determines whether access entity 205-2 is located within the destination (e.g., within the minimum range and the maximum range) and if so, access entity 205-2 broadcasts (414) information associated with the second message (e.g., a traffic condition) to other user devices (e.g., vehicles) within range of access entity 205-2. access entity 205-2 then determines if the message has reached the end of its range (416). For example, access entity 205-2 may

compare the maximum range associated with the message with a distance of access entity 205-2 from access entity 205-1. If the message has not reached the end of its range, a third message is generated (418) based on the second message. For example, the third message may be the same as the second message with the exception of the destination information. For example, the minimum range and the maximum range of the third message may be different (e.g., less than) than the minimum range and the maximum range of the second message. The third message is then communicated to access entity 205-3 (420) where the process associated with access entity 205-2 (e.g., 414-420) are repeated (e.g., repeatedly to access entity 205-n) until the message has reached the end of its range.

[0062] In example implementations, the message can be broadcasted (e.g., blocks 406 and 414) to the intended user devices (vehicles in this case) when the message arrives at the destination access entity(s). In dynamic routing translation, in first implementation, when the minimum range fields equals zero after each decrement, the message is broadcasted from the said access entity and also forwarded to the next hop(s) until the max range field is less than the distance from the next hop. For example, if the max range is less than the distance from the next hop the max range field could equal zero or be set to zero. All the recipients between from the points when min=0 to max=0 also broadcast the message to vehicles along with forwarding it to the next hop. Similar principle applies to the second technique of dynamic range-to-destination translation.

[0063] According to an example implementation, a user device (e.g., a vehicle) in communication with a access entity generates (or controls generation of) a message, determines (or controls determining of) a distance to a target destination of the message, determines (or controls determining of) a direction of the target destination of the message, determines (or controls determining of) a range of transmission, the range of transmission being based on a proportion of the distance to the target destination, determines time-to-live (TTL) of the message based on message classification and communicates the message based on the range of transmission and the TTL, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

[0064] Example implementations may further include determining (or controlling determining of) the range of transmission to include one or more hops. For example, some message types may be addressed to user devices that are not in close proximity to the user device communicating the message. Instead, the message may be communicated to user devices that are located some distance away from the user device

communicating the message. The message may further include a message classification based on, for example, message priority, message type, service type, location, type of user device and/or the like. The message may include geographical coordinates of, for example, an incident, the user device, the target destination and the like. For example, the geographical coordinates may be generated based on a Global Positioning System (GPS) coordinates of the message source in each message obtained through, for example, GPS receivers.

[0065] Example implementations may further include determining (or controlling determining of) the target direction of the message based on the information obtained from traffic safety sensors, local road maps and other traffic information systems. This information can be a compound value that can define one value (e.g., direction of movement of traffic, or opposite to movement of traffic), two values (e.g., both directions on the road), multiple values and/or a field indicating multiple values (e.g., in case of an intersection). Parameters related to over-the-air transmission of the message such as encoding, coding, modulation, Forward Error Correction (FEC), scheduling priority and capacity and/or the like can be adjusted based on the priority of the message. The message can include additional information (e.g., an event causing an expiration) associated with TTL. For example, a TTL associated with a traffic condition may expire should a subsequent message indicate the traffic condition has been cleared.

[0066] In example implementations, the range of transmission and the distance to the target destination can be weighted based on a density and speed of traffic. The TTL can be weighted based on the density and speed of traffic.

[0067] According to an example implementation, a access entity or access entity communicatively coupled to a plurality of other access entities or RSUs can receive (or controls receiving of) a message. The message can include data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission. The range of transmission can be a proportion of the distance to the target destination. Upon receiving the message, the access entity can determine (or controls determining) if the access entity is in the direction of the target destination. If (e.g., upon determining) the access entity is not in the direction of the target destination, the message can be discarded. If (e.g., upon determining) the access entity is in the direction of the target destination, the message can be forwarded by transmitting (or controlling transmission/transmitting) to at least one of the plurality of other access entities and/or broadcasting at least a portion of the message.

[0068] In example implementations, the message may be a broadcasted, controlled to broadcast, message (e.g., one access entity or RSU to many access entities

or RSUs), or a transmitted, controlled to transmit, message (e.g., one access entity or RSU to one access entity or RSU). The access entity may (or may be controlled to) re-determine the range of transmission prior to forwarding the message. The access entity may (or may be controlled to) re-determine the distance to the target destination if (e.g., upon determining) the target destination is a moving target prior to forwarding the message. The access entity may (or may be controlled to) re-determine the direction of the destination prior to forwarding the message.

[0069] In example implementations, the access entity may (or may be controlled to) compare the range of transmission with a distance to at least one of the plurality of other access entities by which the message was broadcast and/ or transmitted from and compare the distance to the target destination with the distance to the at least one of the plurality of other access entities by which the message is to be (or was) broadcast/transmitted. If (e.g., upon determining) the distance to the at least one of the plurality of other access entities by which the message was broadcast/transmitted is not shorter than the range of transmission but shorter than the distance to the target destination, the forwarding is carried out by (or may be controlled to) transmitting to at least one of the plurality of other access entities and (or may be controlled to) broadcasting. If (e.g., upon determining) the distance to the at least one of the plurality of other access entities by which the message is to be transmitted and the range of transmission is shorter than the distance to the target destination, the forwarding is carried out by (or may be controlled to) transmitting to the at least one of the plurality of other access entities. The message can include information on TTL and the forwarding can be carried out in the time period of the TTL

[0070] FIGS. 5 and 6 are flow charts illustrating operation of a node according to at least one example implementation. The steps described with regard to FIGS. 5 and 6 may be performed due to the execution of software code stored in a memory (e.g., memory 706) associated with an apparatus (e.g., a user device, a BS and/or a node as illustrated in FIG. 7) and executed by at least one processor associated (e.g., controller 708) with the apparatus. However, alternative embodiments are contemplated such as a system embodied as a special purpose processor. Although the steps described below are described as being executed by a processor, the steps are not necessarily executed by a same processor. In other words, at least one processor may execute the steps described below with regard to FIGS. 5 and 6.

[0071] FIG. 5 is a flow chart illustrating operation of a device according to at least one example implementation. As shown in FIG. 5 a distance (or remaining distance) to the target destination of a message is determined (S510). For example, a target

destination may be an access entity (or Access entities) in a geographic location where information (e.g., traffic congestion) is relevant. A direction of the target destination of the message is determined (S520). For example, the direction may be based on a source user device (e.g., vehicle) as related to the target destination. A range of transmission is determined (S530). For example, the range may be based on a source user device (e.g., vehicle) as related to a access entity (or Access entities) proximate the target destination. The range of transmission is a proportion of the distance to the target destination. For example, the range can encompass the target destination with regard to an access entity (or Access entities) proximate the target destination. A time-to-live (TTL) of the message based on a message classification is determined (S540). The message is communicated (S550).

[0072] For example, a user device (e.g., vehicle 215-1) may generate a message. In addition to other relevant information (e.g., data indicating what caused the generation of the message), the message may include a communication range (e.g., a minimum range, a maximum range and a direction) and a time-to-live (TTL). The message is communicated based on the range of transmission and the TTL. The message includes data, information on the distance to the target destination, information on the direction of the target destination and information on the range of transmission.

[0073] FIG. 6 is a flow chart illustrating operation of a device (e.g., a node or access entity) according to at least one example implementation. As shown in FIG. 6 a message is received (S610). The message includes data and information on the distance to the target destination, information on the direction of the target destination and information on a range of transmission. The range of the transmission is a proportion of the distance to the target destination (the message may be broadcast or transmitted). Whether the node receiving the message is in the direction of the target destination is determined (S620). For example, the node can determine its geographic position relative to the transmitting node and compare the result to the direction of the target. If the node is not in the direction of the target destination, the message can be discarded (S630). If the node is in the direction of the target destination, the message can be forwarded (S640). The message can be forwarded by transmitting to at least one other node and/or broadcasting at least a portion of the message.

[0074] In an example implementation, on each hop the minimum range field can be decremented based on the geographic distance travelled by the message until the minimum range is zero. On each hop the maximum range field can decremented based on the geographic distance travelled by the message until the maximum range is zero. A discard command can be executed by the node if the node is not the intended recipient

indicated by the direction field of the messages. A forward command can be executed by the node to forward the message to the next hop if both minimum and maximum distances have non-zero values. A forward command can be executed by the node to forward the message to the next hop and a broadcast command can be executed by the node to broadcast the message to all MTC devices within its transmission range if minimum range value is zero while maximum range is non zero until Time-to-Live expires. A broadcast command can be executed by the node to broadcast the message until Time-to-live expires to all MTC devices within its transmission range if both minimum and maximum range has zero values.

[0075] In example implementations, the TTL can have an indefinite value in which case the message is broadcasted until stopped using a special control signal. The node can update the GPS coordinates field of the source or add a new parameter for GPS coordinates of the routing node. The node can determine if the same message is received multiple times originating from the same source and discarding the duplicates. The node can determine if the message is received by a node in the direction not indicated by the message and discarding the message without further action. This can be achieved by comparing the geographic coordinates of the current node and the previous node. The routing may be carried out at the node itself or at a central entity at the network end.

[0076] In an example implementation, an apparatus may include at least one memory including computer instructions, when executed by the at least one processor, cause the apparatus to generate (or control generating) a message by a user device in communication with an access entity, determine (or control determining) a distance to a target destination of the message, determine (or control determining) a direction of the target destination of the message, determine (or control determining) a range of transmission, the range of transmission being based on a proportion of the distance to the target destination, determine (or control determining) time-to-live (TTL) of the message based on message classification, determine (or control determining) at least one destination based on the range of transmission and the TTL, and communicate (or control communicating) the message to the at least one destination, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

[0077] In another example implementation, an apparatus includes at least one processor and at least one memory including computer instructions, when executed by the at least one processor, cause the apparatus to receive (or control receiving) a message by an access entity communicatively coupled to a plurality of other access entities. The

message includes data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and the range of transmission is a proportion of the distance to the target destination. Upon receiving the message, the access entity determines (or controls determining) if the access entity is in the direction of the target destination, upon determining the access entity is not in the direction of the target destination, the access entity discards (or controls discarding) the message, and upon determining the access entity is in the direction of the target destination, the message is forwarded, by the access entity, by at least one of controlling transmitting the message to at least one of the plurality of other access entities or controlling broadcasting at least a portion of the message.

[0078] FIG. 7 is a block diagram of a wireless station (e.g., access entity, RSU, self-backhauling node, BS or user device) 700 according to an example implementation. The wireless station 700 may include, for example, two RF (radio frequency) or wireless transceivers 702A, 702B, where each wireless transceiver includes a transmitter to transmit signals and a receiver to receive signals. The wireless station also includes a processor or control unit/entity (controller) 704 to execute instructions or software and control transmission and receptions of signals, and a memory 706 to store data and/or instructions.

[0079] Processor 704 may also make decisions or determinations, generate frames, packets or messages for transmission, decode received frames or messages for further processing, and other tasks or functions described herein. Processor 704, which may be a baseband processor, for example, may generate messages, packets, frames or other signals for transmission via wireless transceiver 702 (702A or 702B). Processor 704 may control transmission of signals or messages over a wireless network, and may control the reception of signals or messages, etc., via a wireless network (e.g., after being down-converted by wireless transceiver 702, for example). Processor 704 may be programmable and capable of executing software or other instructions stored in memory or on other computer media to perform the various tasks and functions described above, such as one or more of the tasks or methods described above. For example, processor 704 may be programmable and capable of executing software associated methods described with regard to one or more of FIGS. 4, 5 and 6. Processor 704 may be (or may include), for example, hardware, programmable logic, a programmable processor that executes software or firmware, and/or any combination of these. Using other terminology, processor 704 and transceiver 702 together may be considered as a wireless transmitter/receiver system, for example.

[0080] In addition, referring to FIG. 7, a controller (or processor) 708 may execute

software and instructions, and may provide overall control for the station 700, and may provide control for other systems not shown in FIG. 7, such as controlling input/output devices (e.g., display, keypad), and/or may execute software for one or more applications that may be provided on wireless station 700, such as, for example, an email program, audio/video applications, a word processor, a Voice over IP application, or other application or software.

[0081] In addition, a storage medium may be provided that includes stored instructions, which when executed by a controller or processor may result in the processor 704, or other controller or processor, performing one or more of the functions or tasks described above.

[0082] According to another example implementation, RF or wireless transceiver(s) 702A/702B may receive signals or data and/or transmit or send signals or data. Processor 704 (and possibly transceivers 702A/702B) may control the RF or wireless transceiver 702A or 702B to receive, send, broadcast or transmit signals or data.

[0083] According to an example implementation, a user device (e.g., the vehicles 215-1, 215-2, 215-3, 215-n) and/or a node (e.g., Access entities 205-1, 205-2, 205-3, 205-n) may include a processor 704, a controller 708, memory 706, input/output devices (not shown), one or more network interfaces (not shown), and other computer hardware and/or software which may be provided on a computer, server or other computing device. According to one illustrative example implementation, user device and/or node may each include software running on a computer, server, or other computing device, where the computing device may include a processor 704, a controller 708, a memory 706, etc. Also, in another example implementation, a host, computing node or server (which may include all or part of the functionality of the user device and/or the node) may be coupled (e.g., operationally coupled) to a remote radio head, one or more BSs, and/or other wireless infrastructure, or infrastructure associated with one or more sharing partners.

[0084] An example of an apparatus may also include means (e.g., 704 or 708) for determining a change in an assignment state for the network resource that is shared among a plurality of sharing partners, and means (e.g., 704 or 708) for determining, for one or more of the sharing partners, information access authorization for access to the resource information related to the network resource based on the determining the change in assignment state for protecting the resource information.

[0085] An example of an apparatus may also include means (e.g., 704 or 708) for generating a message by a user device in communication with a access entity, means (e.g., 704 or 708) for determining a distance to a target destination of the message,

means (e.g., 704 or 708) for determining a direction of the target destination of the message, means (e.g., 704 or 708) for determining a range of transmission, the range of transmission being based on a proportion of the distance to the target destination, means (e.g., 704 or 708) for determining time-to-live (TTL) of the message based on message classification, and means (e.g., 704 or 708) for communicating the message based on the range of transmission and the TTL, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

[0086] An example of an apparatus may also include means (e.g., 704 or 708) for receiving a message by a access entity communicatively coupled to a plurality of other access entities, the message includes data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and the range of transmission is a proportion of the distance to the target destination. Upon receiving the message, the example apparatus may also include means (e.g., 704 or 708) for determining if the access entity is in the direction of the target destination. Upon determining the access entity is not in the direction of the target destination, the example apparatus may also include means (e.g., 704 or 708) for discarding the message. Upon determining the access entity is in the direction of the target destination, the example apparatus may also include means (e.g., 704 or 708) for forwarding the message by at least one of transmitting the message to at least one of the plurality of other access entities or broadcasting at least a portion of the message.

[0087] The embodiments are not, however, restricted to the system that is given as an example, but a person skilled in the art may apply the solution to other communication systems. Another example of a suitable communications system is the 5G concept. It is assumed that network architecture in 5G will be quite similar to that of the LTE-advanced. 5G is likely to use multiple input -multiple output (MIMO) antennas, many more base stations or nodes than the LTE (a so-called small cell concept), including macro sites operating in co-operation with smaller stations and perhaps also employing a variety of radio technologies for better coverage and enhanced data rates.

[0088] It should be appreciated that future networks will most probably utilise network functions virtualization (NFV) which is a network architecture concept that proposes virtualizing network node functions into “building blocks” or entities that may be operationally connected or linked together to provide services. A virtualized network function (VNF) may comprise one or more virtual machines running computer program codes using standard or general type servers instead of customized hardware. Cloud

computing or data storage may also be utilized. In radio communications this may mean node operations may be carried out, at least partly, in a server, host or node operationally coupled to a remote radio head. It is also possible that node operations will be distributed among a plurality of servers, nodes or hosts. It should also be understood that the distribution of labour between core network operations and base station operations may differ from that of the LTE or even be non-existent.

[0089] Example embodiments described herein may provide additional reliability for MTC type of traffic compounded with a possibility for the network to optimize the number of messages used for this purpose. In example implementations, through the usage of access entities or RSUs, messages may be relayed to other MTC devices through network infrastructure and not only with the direct D2D link. This has a positive impact on message delivery redundancy and reliability. At the same time, because Access entities are used for this purpose the "normal" wide-area base-stations are not heavily occupied and can devote their resources for other purposes. In example implementations, the network (via the access entities or RSUs) may acquire a way to determine how wide-spread a given MTC type of message shall be propagated. As mentioned above this may be achieved through various means, e.g. by assessing the mean vehicle speed, vehicle density, access entity or RSU distance, geographical location, weather conditions, message priority, etc. As a result this forms a useful way to control the number of messages and to stop the network from being over-congested ensuring at the same time the needed redundancy and reliability of those messages.

[0090] Implementations of the various techniques described herein may be implemented in digital electronic circuitry, or in computer hardware, firmware, software, or in combinations of them. Implementations may implemented as a computer program product, i.e., a computer program tangibly embodied in an information carrier, e.g., in a machine-readable storage device or in a propagated signal, for execution by, or to control the operation of, a data processing apparatus, e.g., a programmable processor, a computer, or multiple computers. Implementations may also be provided on a computer readable medium or computer readable storage medium, which may be a non-transitory medium. Implementations of the various techniques may also include implementations provided via transitory signals or media, and/or programs and/or software implementations that are downloadable via the Internet or other network(s), either wired networks and/or wireless networks. In addition, implementations may be provided via machine type communications (MTC), and also via an Internet of Things (IOT).

[0091] The computer program may be in source code form, object code form, or in some intermediate form, and it may be stored in some sort of carrier, distribution medium,

or computer readable medium, which may be any entity or device capable of carrying the program. Such carriers include a record medium, computer memory, read-only memory, photoelectrical and/or electrical carrier signal, telecommunications signal, and software distribution package, for example. Depending on the processing power needed, the computer program may be executed in a single electronic digital computer or it may be distributed amongst a number of computers.

[0092] Furthermore, implementations of the various techniques described herein may use a cyber-physical system (CPS) (a system of collaborating computational elements controlling physical entities). CPS may enable the implementation and exploitation of massive amounts of interconnected ICT devices (sensors, actuators, processors microcontrollers, and/or the like) embedded in physical objects at different locations. Mobile cyber physical systems, in which the physical system in question has inherent mobility, are a subcategory of cyber-physical systems. Examples of mobile physical systems include mobile robotics and electronics transported by humans or animals. The rise in popularity of smartphones has increased interest in the area of mobile cyber-physical systems. Therefore, various implementations of techniques described herein may be provided via one or more of these technologies.

[0093] Methods discussed above, some of which are illustrated by the flow charts, may be implemented by hardware, software, firmware, middleware, microcode, hardware description languages, or any combination thereof. When implemented in software, firmware, middleware or microcode, the program code, the computer executable program code or code segments to perform the necessary tasks may be stored in or on a machine or computer readable medium such as a storage medium and/or a non-transitory computer-readable storage medium. A processor(s) (e.g., a silicon or GaAs based processor) may perform the necessary tasks. For example, hardware, software, firmware, middleware, microcode, hardware description languages, or any combination thereof may be capable of implementing methods described with regard to one or more of FIGS. 4, 5 and 6.

[0094] A computer program, such as the computer program(s) described above, can be written in any form of programming language, including compiled or interpreted languages, and can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, or other unit or part of it suitable for use in a computing environment. A computer program can be deployed to be executed on one computer or on multiple computers at one site or distributed across multiple sites and interconnected by a communication network.

[0095] Method steps may be performed by one or more programmable processors

executing a computer program or computer program portions to perform functions by operating on input data and generating output. Method steps also may be performed by, and an apparatus may be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit).

[0096] Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer, chip or chipset. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. Elements of a computer may include at least one processor for executing instructions and one or more memory devices for storing instructions and data. Generally, a computer also may include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. Information carriers suitable for embodying computer program instructions and data include all forms of non-volatile memory, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory may be supplemented by, or incorporated in, special purpose logic circuitry.

[0097] To provide for interaction with a user, implementations may be implemented on a computer having a display device, e.g., a cathode ray tube (CRT) or liquid crystal display (LCD) monitor, for displaying information to the user and a user interface, such as a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input.

[0098] Implementations may be implemented in a computing system that includes a back-end component, e.g., as a data server, or that includes a middleware component, e.g., an application server, or that includes a front-end component, e.g., a client computer having a graphical user interface or a Web browser through which a user can interact with an implementation, or any combination of such back-end, middleware, or front-end components. Components may be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a local area network (LAN) and a wide area network (WAN), e.g., the Internet.

[0099] While certain features of the described implementations have been

illustrated as described herein, many modifications, substitutions, changes and equivalents will now occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the various embodiments.

WHAT IS CLAIMED IS:

1. A method comprising:

control generating a message by a user device in communication with an access entity;

control determining a distance to a target destination of the message;

control determining a direction of the target destination of the message;

control determining a range of transmission, the range of transmission being based on a proportion of the distance to the target destination;

control determining time-to-live (TTL) of the message based on message classification;

control determining at least one destination based on the range of transmission and the TTL; and

control communicating the message to the at least one destination, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

2. The method of claim 1, further comprising:

control determining at least one intermediate destination, wherein the controlling of the communicating of the message includes controlling the communicating of the message to the at least one intermediate destination.

3. The method of claims 1-2, further comprising:

control determining the range of transmission to include one or more hops.

4. The method of any of claims 1-3, wherein at least one message type is addressed to at least one other user device that is not in close proximity to the user device.

5. The method of any of claims 1-4, wherein the message further includes a message classification based on at least one of a message priority, a message type, a service type, a location, a type of user device.

6. The method of any of claims 1-5, wherein the message further includes geographical coordinates of at least one of an incident, the user device and the target destination.

7. The method of claim 6, wherein the geographical coordinates are generated based on Global Positioning System (GPS) coordinates of a message source.

8. The method of any of claims 1-7, further comprising:
control determining the direction of the target destination is based on information obtained from at least one of a traffic safety sensor, a local road map and other traffic information systems.

9. The method of claim 8, wherein the obtained information is a compound value that defines one of a single value, two values or a field indicating multiple values.

10. The method of any of claims 1-9, further comprising:
control determining a priority of the message, wherein parameters related to over-the-air transmission of the message are adjusted based on the priority of the message.

11. The method of any of claims 1-10, wherein the message further includes information associated with a TTL of an earlier in time message.

12. The method of any of claims 1-11, wherein the TTL has an indefinite value indicating the message is to be broadcasted until stopped using a special control signal.

13. The method of any of claims 1-12, wherein
the range of transmission and the distance to the target destination are weighted based on a density and speed of traffic, and
the TTL is weighted based on the density and speed of traffic.

14. The method of any of claims 1-13, further comprising:
upon determining a road distance between two access entities is greater than a Euclidean distance between the two access entities, control compensating for the road distance.

15. An apparatus comprising means for carrying out the method according to any one of claims 1- 14.

16. A computer program product for a computer, comprising software code portions for performing the steps of any of claims 1-14 when said product is run on the computer.

17. An apparatus comprising at least one processor and at least one memory including computer instructions, when executed by the at least one processor, cause the apparatus to:

control generating a message by a user device in communication with a access entity;

control determining a distance to a target destination of the message;

control determining a direction of the target destination of the message;

control determining a range of transmission, the range of transmission being based on a proportion of the distance to the target destination;

control determining time-to-live (TTL) of the message based on message classification; and

control communicating the message based on the range of transmission and the TTL, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

18. The apparatus of claim 17, further comprising:

control determining at least one intermediate destination, wherein the controlling of the communicating of the message includes controlling the communicating of the message to the at least one intermediate destination.

19. The apparatus of claims 17-18 and further comprising the instructions causing the apparatus to:

control determining the range of transmission to include one or more hops.

20. The apparatus of any of claims 17-19, wherein at least one message type is addressed to at least one other user device that is not in close proximity to the user device.

21. The apparatus of any of claims 17-20, wherein the message further includes a message classification based on at least one of a message priority, a message type, a service type, a location, a type of user device.

22. The apparatus of any of claims 17-21, wherein the message further includes geographical coordinates of at least one of an incident, the user device and the target destination.

23. The apparatus of claim 22, wherein the geographical coordinates are generated based on Global Positioning System (GPS) coordinates of a message source.

24. The apparatus of any of claims 17-23 and further comprising the instructions causing the apparatus to:

control determining the direction of the target destination is based on information obtained from at least one of a traffic safety sensor, a local road map and other traffic information systems.

25. The apparatus of claim 24, wherein the obtained information is a compound value that defines one of a single value, two values or a field indicating multiple values.

26. The apparatus of any of claims 17-25 and further comprising the instructions causing the apparatus to:

control determining a priority of the message, wherein parameters related to over-the-air transmission of the message are adjusted based on the priority of the message.

27. The apparatus of any of claims 17-26, wherein the message further includes information associated with a TTL of an earlier in time message.

28. The apparatus of any of claims 17-27, wherein the TTL has an indefinite value indicating the message is to be broadcasted until stopped using a special control signal.

29. The apparatus of any of claims 17-28, wherein

the range of transmission and the distance to the target destination are weighted based on a density and speed of traffic, and

the TTL is weighted based on the density and speed of traffic.

30. The apparatus of any of claims 17-29 and further comprising the instructions causing the apparatus to:

upon determining a road distance between two access entities is greater than a Euclidean distance between the two access entities, control compensating for the road distance.

31. A computer program product, the computer program product comprising a non-transitory computer-readable storage medium and storing executable code that, when executed by at least one data processing apparatus, is configured to cause the at least one data processing apparatus to perform a method comprising:

control generating a message by a user device in communication with a access entity;

control determining a distance to a target destination of the message;

control determining a direction of the target destination of the message;

control determining a range of transmission, the range of transmission being based on a proportion of the distance to the target destination;

control determining time-to-live (TTL) of the message based on message classification; and

control communicating the message based on the range of transmission and the TTL, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

32. An apparatus comprising:

means for generating a message by a user device in communication with a access entity;

means for determining a distance to a target destination of the message;

means for determining a direction of the target destination of the message;

means for determining a range of transmission, the range of transmission being based on a proportion of the distance to the target destination;

means for determining time-to-live (TTL) of the message based on message classification; and

means for communicating the message based on the range of transmission and the TTL, the message including information based on the distance to the target destination, information based on the direction of the target destination and information based on the range of transmission.

33. A method comprising:

control receiving a message by an access entity communicatively coupled to a plurality of other access entities, wherein

the message includes data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and

the range of transmission is a proportion of the distance to the target destination;

upon receiving the message, the access entity determines if the access entity is in the direction of the target destination;

upon determining the access entity is not in the direction of the target destination, discarding the message; and

upon determining the access entity is in the direction of the target destination, the message is forwarded by at least one of controlling transmitting the message to at least one of the plurality of other access entities or controlling broadcasting at least a portion of the message.

34. The method of claim 33, wherein the message is one of a broadcasted message or a transmitted message.

35. The method of any of claims 33-34, further comprising:

control re-determining, by the access entity, the range of transmission prior to forwarding the message.

36. The method of any of claims 33-35, further comprising:

control re-determining, by the access entity, the distance to the target destination upon determining the target destination is a moving target prior to forwarding the message.

37. The method of any of claims 33-36, further comprising:

control re-determining, by the access entity, the direction of the target destination prior to forwarding the message.

38. The method of any of claims 33-37, further comprising:

control comparing, by the access entity, the range of transmission with a distance to at least one of the plurality of other access entities by which the message received;

control comparing, by the access entity, the distance to the target destination with the distance to the at least one of the plurality of other access entities by which the message is to be transmitted; and

upon determining the distance to the at least one of the plurality of other access entities by which the message is to be transmitted is not shorter than the range of transmission and is shorter than the distance to the target destination, the forwarding is carried out by controlling transmitting to at least one of the plurality of other access entities and controlling broadcasting.

39. The method of any of claims 33-38, further comprising:

comparing, by the access entity, the range of transmission with a distance to at least one of the plurality of other access entities by which the message received;

comparing, by the access entity, the distance to the target destination with the distance to the at least one of the plurality of other access entities by which the message is to be transmitted; and

upon determining the distance to the at least one of the plurality of other access entities by which the message is to be transmitted and the range of transmission is shorter than the distance to the target destination, the forwarding is carried out by controlling transmitting to the at least one of the plurality of other access entities.

40. The method of any of claims 33-39, wherein

the message includes information on TTL, and

the forwarding is carried out in a time period of the TTL.

41. The method of any of claims 33-40, further comprising:

upon determining a road distance between two access entities is greater than a Euclidean distance between the two access entities, control compensating for the road distance.

42. An apparatus comprising means for carrying out the method according to any one of claims 33-41.

43. A computer program product for a computer, comprising software code portions for performing the steps of any of claims 33-41 when said product is run on the computer.

44. An apparatus comprising at least one processor and at least one memory including computer instructions, when executed by the at least one processor, cause the apparatus to:

control receiving a message by a access entity communicatively coupled to a plurality of other access entities, wherein

the message includes data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and

the range of transmission is a proportion of the distance to the target destination;

upon receiving the message, control determining if the access entity is in the direction of the target destination;

upon determining the access entity is not in the direction of the target destination, control discarding the message; and

upon determining the access entity is in the direction of the target destination, the message is forwarded by at least one of controlling transmitting the message to at least one of the plurality of other access entities or controlling broadcasting at least a portion of the message.

45. The apparatus of claim 44, wherein the message is one of a broadcasted message or a transmitted message.

46. The apparatus of any of claims 44-45 and further comprising the instructions causing the apparatus to:

control re-determining the range of transmission prior to forwarding the message.

47. The apparatus of any of claims 44-46 and further comprising the instructions causing the apparatus to:

control re-determining the distance to the target destination upon determining the target destination is a moving target prior to forwarding the message.

48. The apparatus of any of claims 44-47 and further comprising the instructions causing the apparatus to:

control re-determining the direction of the target destination prior to forwarding the message.

49. The apparatus of any of claims 44-48 and further comprising the instructions causing the apparatus to:

control comparing the range of transmission with a distance to at least one of the plurality of other access entities by which the message received; and

control comparing the distance to the target destination with the distance to the at least one of the plurality of other access entities by which the message is to be transmitted, wherein

upon determining the distance to the at least one of the plurality of other access entities by which the message is to be transmitted is not shorter than the range of transmission and is shorter than the distance to the target destination, the forwarding is carried out by controlling transmitting to at least one of the plurality of other access entities and controlling broadcasting.

50. The apparatus of any of claims 44-49 and further comprising the instructions causing the apparatus to:

control comparing the range of transmission with a distance to at least one of the plurality of other access entities by which the message received; and

control comparing the distance to the target destination with the distance to the at least one of the plurality of other access entities by which the message is to be transmitted, wherein

upon determining the distance to the at least one of the plurality of other access entities by which the message is to be transmitted and the range of transmission is shorter than the distance to the target destination, the forwarding is carried out by controlling transmitting to the at least one of the plurality of other access entities.

51. The apparatus of any of claims 44-50, wherein

the message includes information on TTL, and

the forwarding is carried out in a time period of the TTL.

52. The apparatus of any of claims 44-51 and further comprising the instructions causing the apparatus to:

upon determining a road distance between two access entities is greater than a Euclidean distance between the two access entities, control compensating for the road distance.

53. A computer program product, the computer program product comprising a non-transitory computer-readable storage medium and storing executable code that, when executed by at least one data processing apparatus, is configured to cause the at least one data processing apparatus to perform a method comprising:

control receiving a message by a access entity communicatively coupled to a plurality of other access entities, wherein

the message includes data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and

the range of transmission is a proportion of the distance to the target destination;

upon receiving the message, control determining if the access entity is in the direction of the target destination;

upon determining the access entity is not in the direction of the target destination, discarding the message; and

upon determining the access entity is in the direction of the target destination, the message is forwarded by at least one of control transmitting the message to at least one of the plurality of other access entities or control broadcasting at least a portion of the message.

54. An apparatus comprising:

means for receiving a message by a access entity communicatively coupled to a plurality of other access entities, wherein

the message includes data and information based on a distance to a target destination, information based on a direction of the target destination and information on a range of transmission, and

the range of transmission is a proportion of the distance to the target destination;

upon receiving the message, means for determining if the access entity is in the direction of the target destination;

upon determining the access entity is not in the direction of the target destination, means for discarding the message; and

upon determining the access entity is in the direction of the target destination, means for forwarding the message by at least one of transmitting the message to at least one of the plurality of other access entities or broadcasting at least a portion of the message.

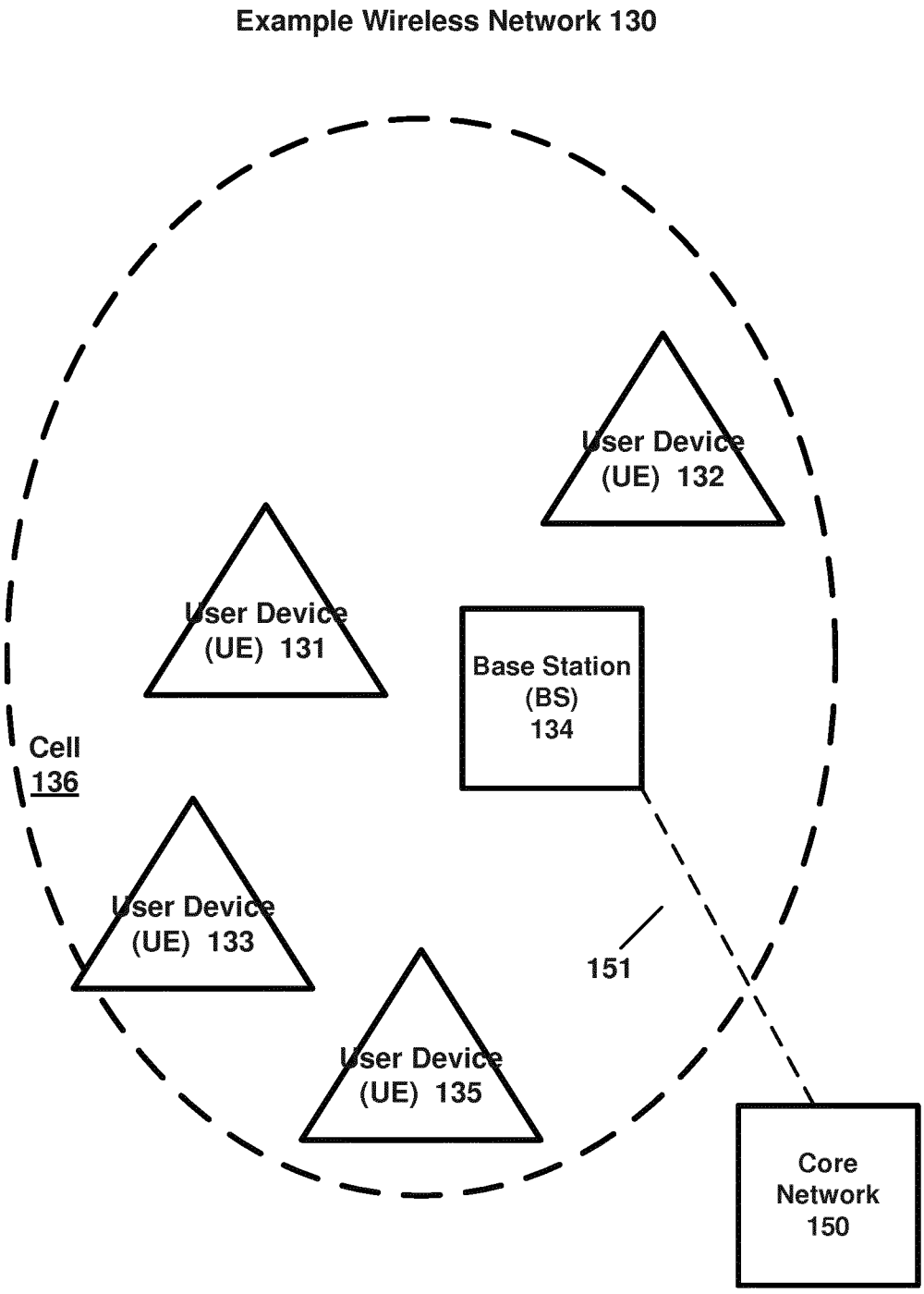

Example Wireless Network 130
User Device
(UE) 132
User Device
(UE) 131
Base Station
(BS)
134
Cell
136
User Device
(UE) 133
151
User Device
(UE) 135
Core
Network
150

FIG. 1

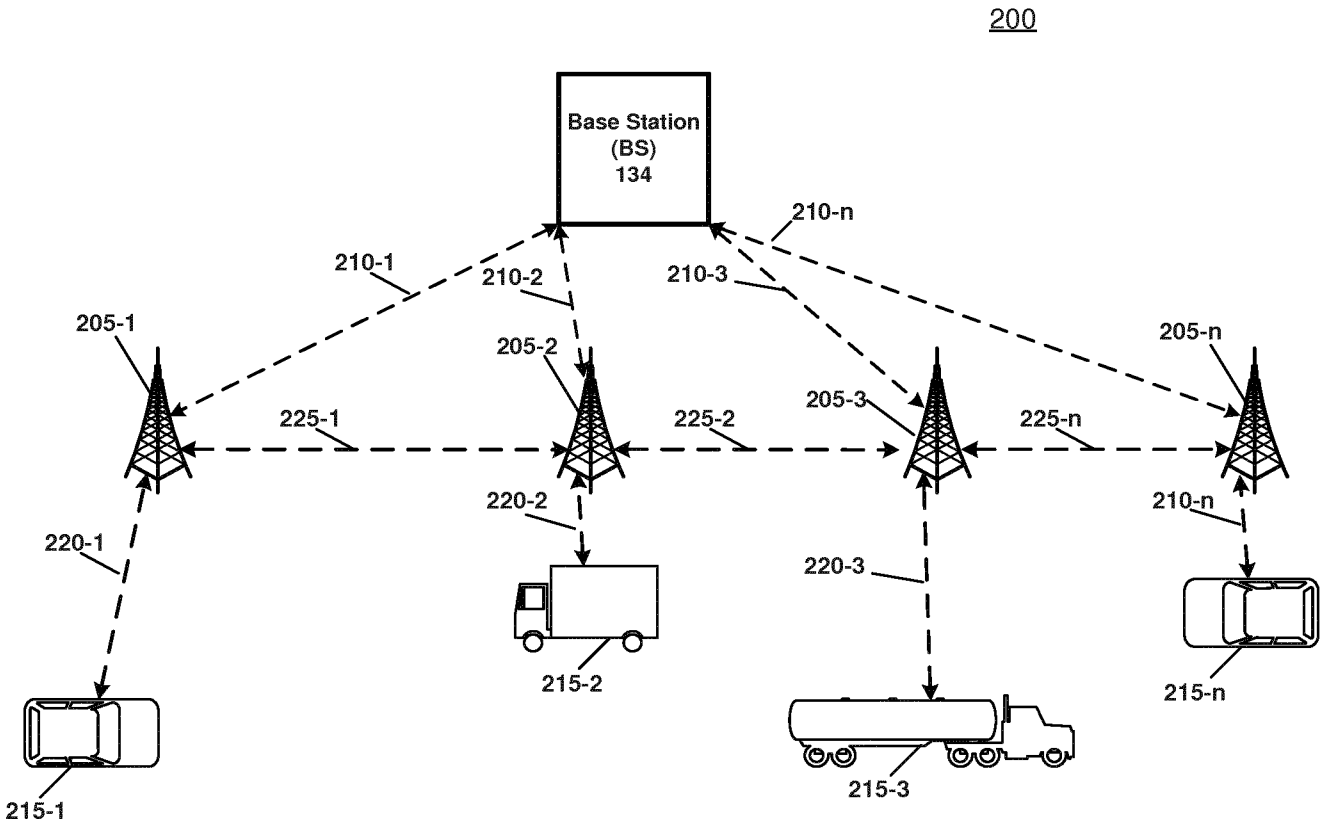

200
Base Station
(BS)
134
210-1
210-2
210-3
210-n
205-1
205-2
205-3
205-n
225-1
225-2
225-n
220-1
220-2
220-3
210-n
215-1
215-2
215-3
215-n

FIG. 2

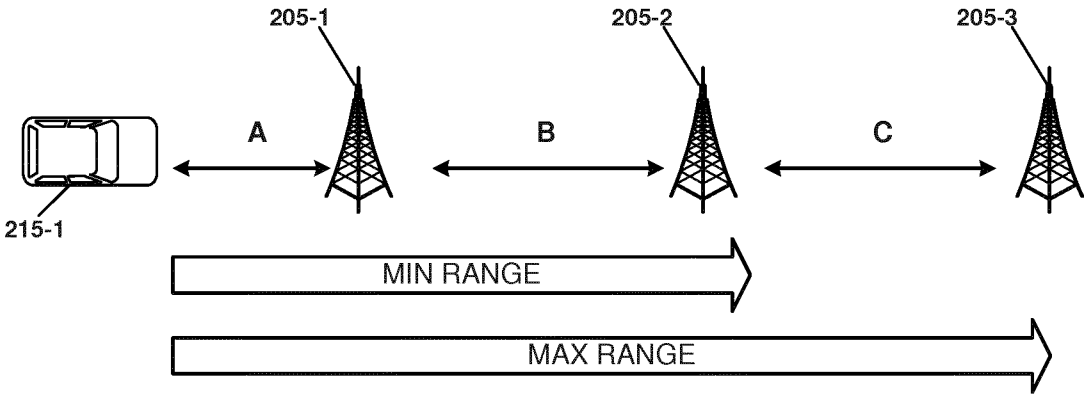


FIG. 3

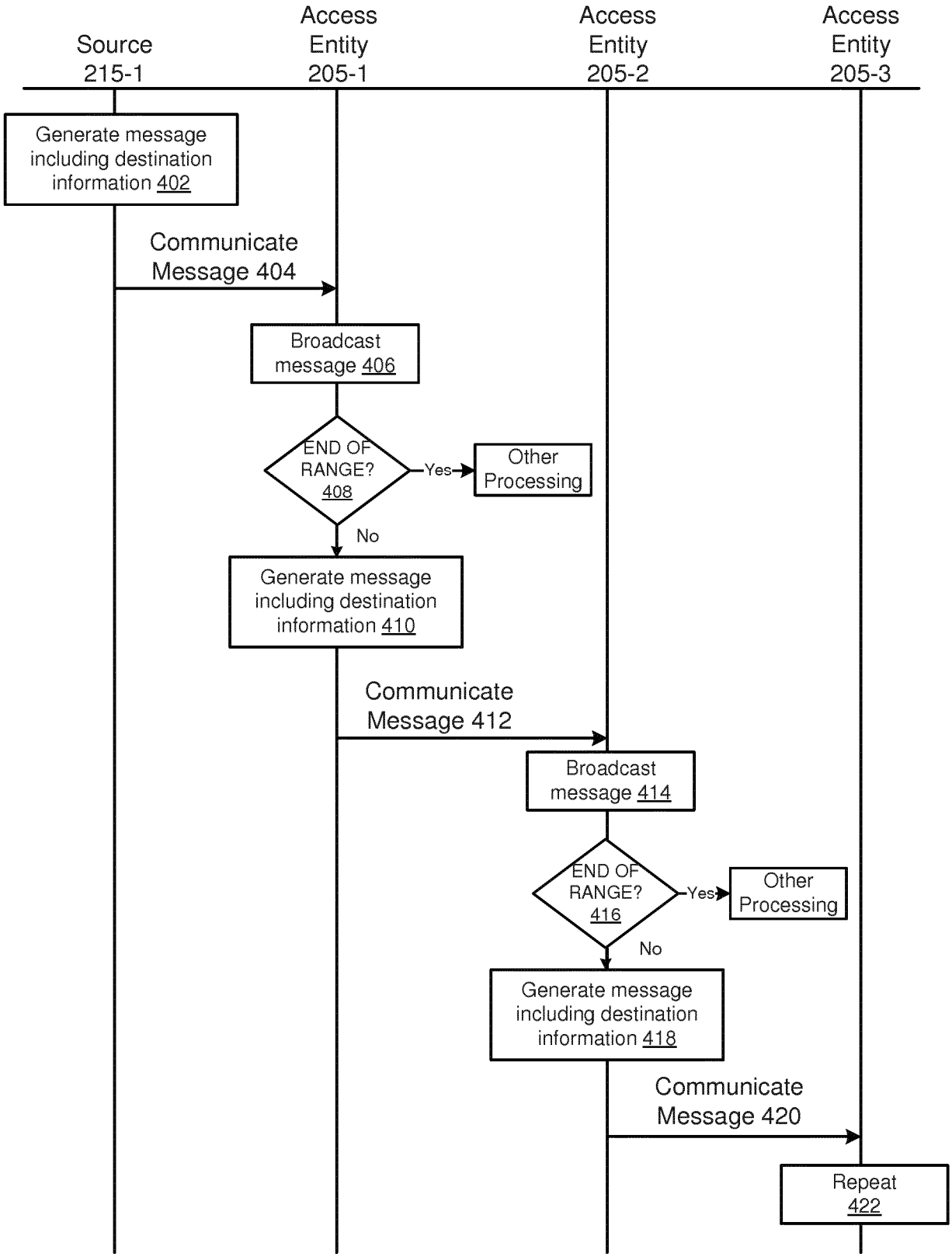

Source 215-1
Access Entity 205-1
Access Entity 205-2
Access Entity 205-3
Generate message including destination information 402
Communicate Message 404
Broadcast message 406
END OF RANGE? 408
Yes
Other Processing
No
Generate message including destination information 410
Communicate Message 412
Broadcast message 414
END OF RANGE? 416
Yes
Other Processing
No
Generate message including destination information 418
Communicate Message 420
Repeat 422

FIG. 4

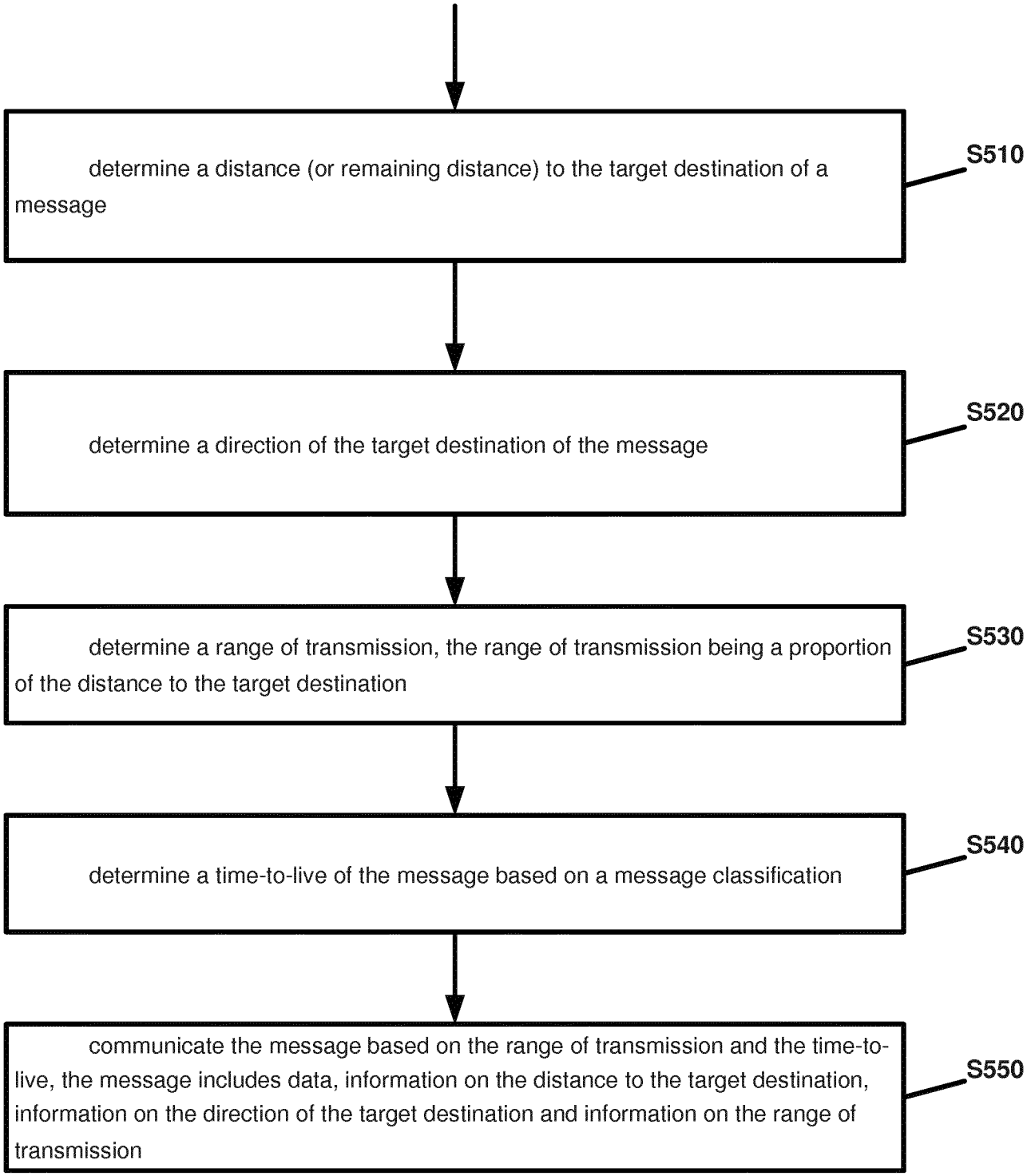

determine a distance (or remaining distance) to the target destination of a message
S510
determine a direction of the target destination of the message
S520
determine a range of transmission, the range of transmission being a proportion of the distance to the target destination
S530
determine a time-to-live of the message based on a message classification
S540
communicate the message based on the range of transmission and the time-to-live, the message includes data, information on the distance to the target destination, information on the direction of the target destination and information on the range of transmission
S550

FIG. 5

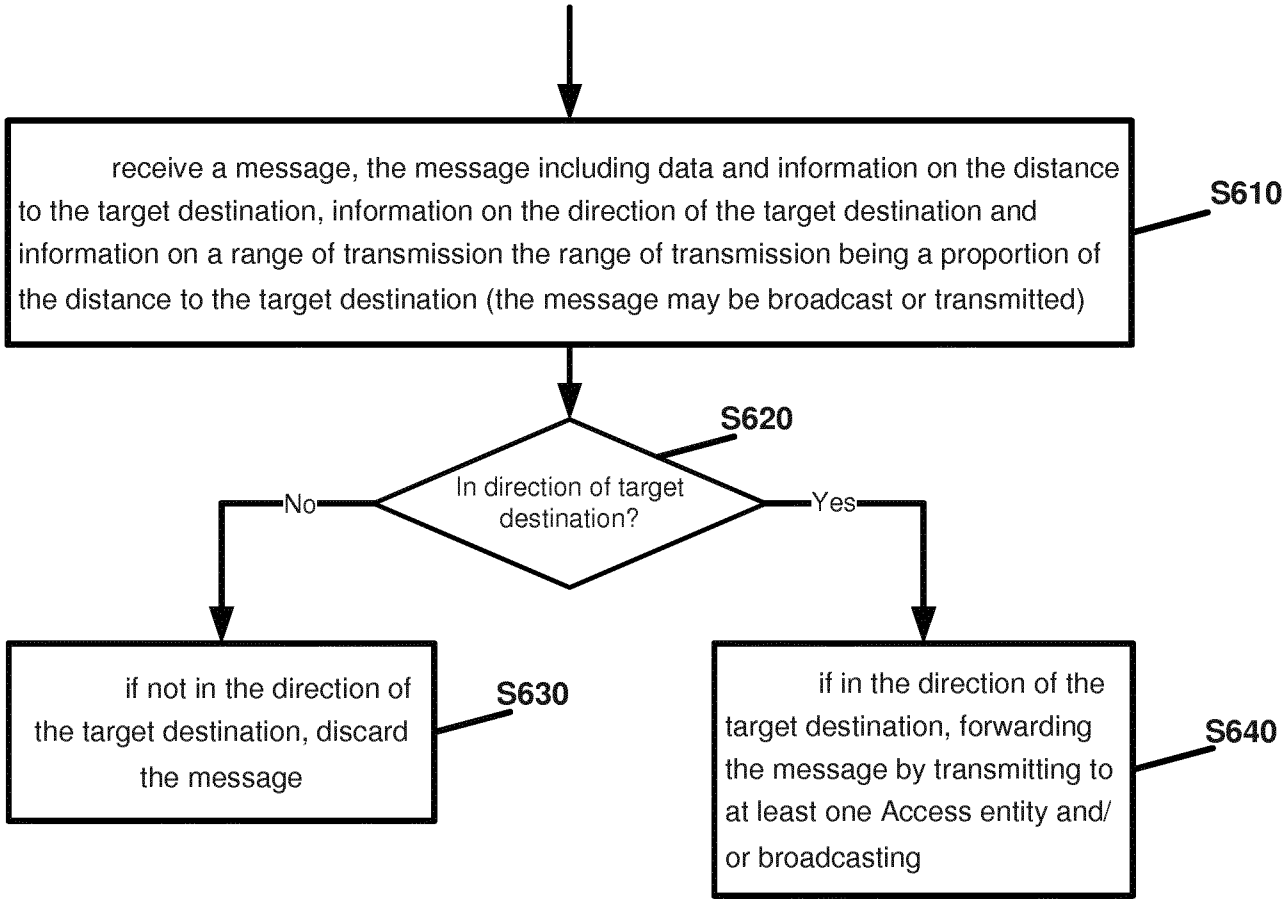

receive a message, the message including data and information on the distance to the target destination, information on the direction of the target destination and information on a range of transmission the range of transmission being a proportion of the distance to the target destination (the message may be broadcast or transmitted)
S610
S620
In direction of target destination?
No
Yes
if not in the direction of the target destination, discard the message
S630
if in the direction of the target destination, forwarding the message by transmitting to at least one Access entity and/ or broadcasting
S640

FIG. 6

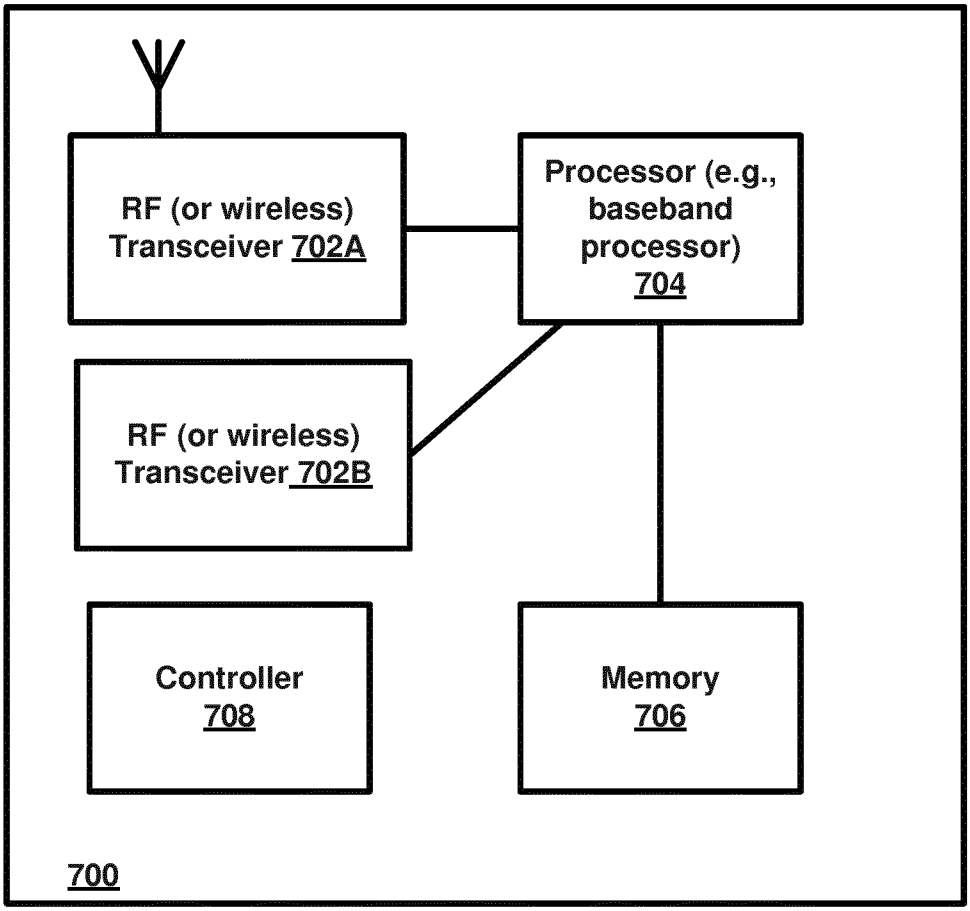

RF (or wireless) Transceiver 702A
Processor (e.g., baseband processor) 704
RF (or wireless) Transceiver 702B
Controller 708
Memory 706
700

FIG. 7

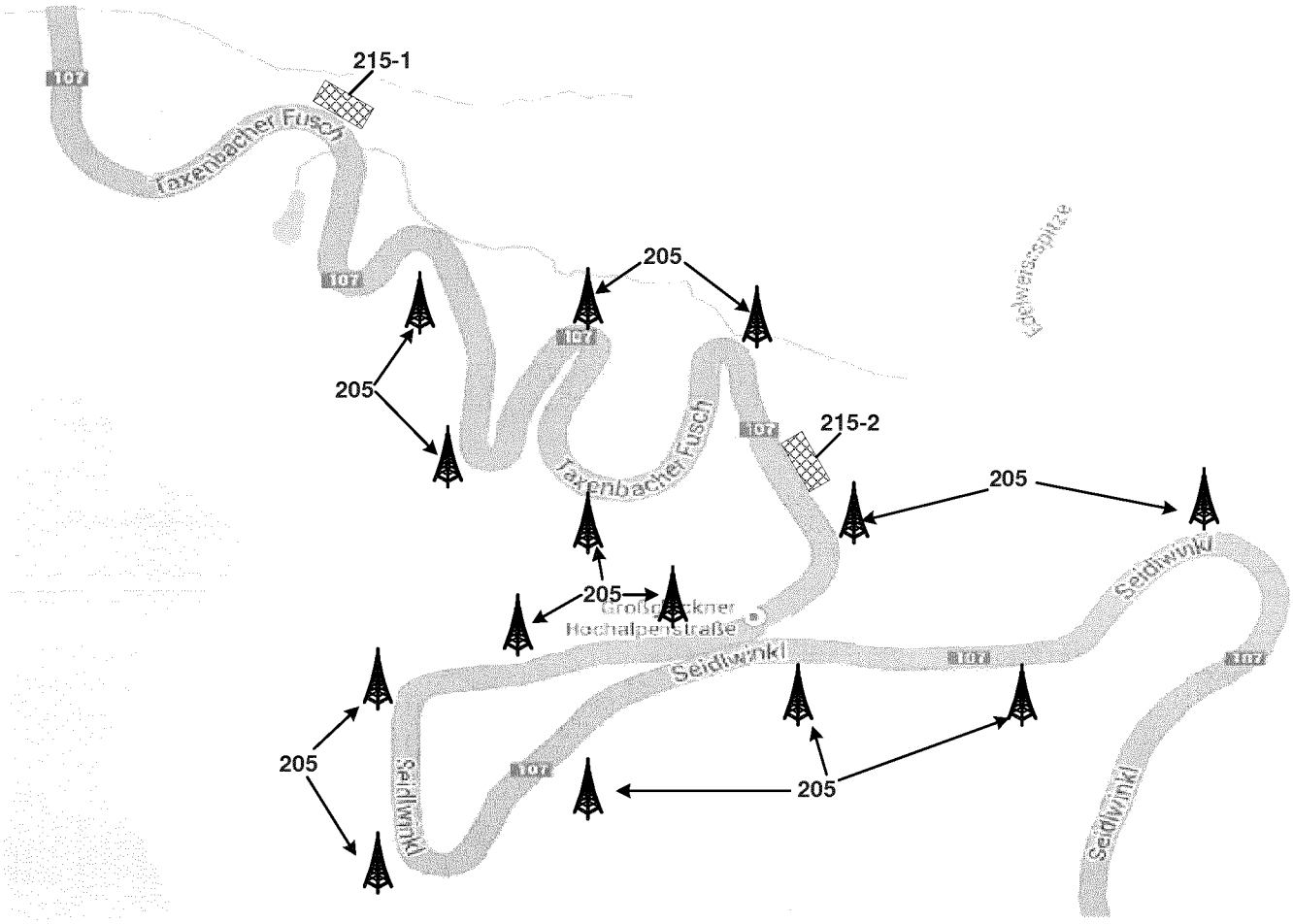

215-1
Taxenbacher Fusch
205
205
215-2
Taxenbacher Fusch
205
205
Großglockner
Hochalpenstraße
Seidlwinkl
Seidlwinkl
Seidlwinkl
205
205
Seidlwinkl

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/051675

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W40/20
ADD. G08G1/16 H04W88/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G08G H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FU MAOCAI ET AL: "TMODF: Trajectory-based multi-objective optimal data forwarding in vehicular networks", 2014 IEEE 33RD INTERNATIONAL PERFORMANCE COMPUTING AND COMMUNICATIONS CONFERENCE (IPCCC), IEEE, 5 December 2014 (2014-12-05), pages 1-8, XP032725883, DOI: 10.1109/PCCC.2014.7017077 [retrieved on 2015-01-20] page 4	1-32
X	US 2012/003921 A1 (SCOPIGNO RICCARDO MARIA [IT] ET AL) 5 January 2012 (2012-01-05) paragraphs [0018], [0019], [0022] - [0027]	33-54

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 September 2015	02/10/2015

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2015/051675

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012003921 A1	05-01-2012	NONE	