REFERENCE INFORMATION FOR REFERENCE SIGNAL TIME DIFFERENCE

FIELD

The following example embodiments relate to wireless communication and to positioning.

BACKGROUND

Positioning technologies may be used to estimate a physical location of a device. It is desirable to improve the positioning accuracy in order to estimate the location of the device more accurately.

BRIEF DESCRIPTION

The scope of protection sought for various example embodiments is set out by the independent claims. The example embodiments and features, if any, described in this specification that do not fall under the scope of the independent claims are to be interpreted as examples useful for understanding various embodiments.

According to an aspect, there is provided an apparatus in a radio access network, the apparatus comprising at least one processor, and at least one memory storing instructions which, when executed by the at least one processor, cause the apparatus at least to: select at least one user device from one or more candidate user devices as a reference for reference signal time difference, RSTD, measurement; measure an RSTD between at least two reference signals, wherein the at least two reference signals comprise at least a sidelink positioning reference signal received from the at least one user device selected as the reference; and transmit, to a network element of a core network, a report comprising at least one of: an identifier of the at least one user device selected as the reference for the RSTD measurement, an identifier of a resource associated with the sidelink positioning reference signal received from the at least one user device, synchronization source information indicating at least one synchronization source of the at least one user device, or a time stamp of the sidelink positioning reference signal received from the at least one user device.

According to another aspect, there is provided an apparatus in a radio access network, the apparatus comprising: means for selecting at least one user device

from one or more candidate user devices as a reference for reference signal time difference, RSTD, measurement; means for measuring an RSTD between at least two reference signals, wherein the at least two reference signals comprise at least a sidelink positioning reference signal received from the at least one user device selected as the reference; and means for transmitting, to a network element of a core network, a report comprising at least one of: an identifier of the at least one user device selected as the reference for the RSTD measurement, an identifier of a resource associated with the sidelink positioning reference signal received from the at least one user device, synchronization source information indicating at least one synchronization source of the at least one user device, or a time stamp of the sidelink positioning reference signal received from the at least one user device.

According to another aspect, there is provided a method comprising: selecting, by an apparatus in a radio access network, at least one user device from one or more candidate user devices as a reference for reference signal time difference, RSTD, measurement; measuring, by the apparatus, an RSTD between at least two reference signals, wherein the at least two reference signals comprise at least a sidelink positioning reference signal received from the at least one user device selected as the reference; and transmitting, by the apparatus, to a network element of a core network, a report comprising at least one of: an identifier of the at least one user device selected as the reference for the RSTD measurement, an identifier of a resource associated with the sidelink positioning reference signal received from the at least one user device, synchronization source information indicating at least one synchronization source of the at least one user device, or a time stamp of the sidelink positioning reference signal received from the at least one user device.

According to another aspect, there is provided a computer program comprising instructions which, when executed by an apparatus in a radio access network, cause the apparatus to perform at least the following: selecting at least one user device from one or more candidate user devices as a reference for reference signal time difference, RSTD, measurement; measuring an RSTD between at least two reference signals, wherein the at least two reference signals comprise at least a sidelink positioning reference signal received from the at least one user device selected as the

reference; and transmitting, to a network element of a core network, a report comprising at least one of: an identifier of the at least one user device selected as the reference for the RSTD measurement, an identifier of a resource associated with the sidelink positioning reference signal received from the at least one user device, synchronization source information indicating at least one synchronization source of the at least one user device, or a time stamp of the sidelink positioning reference signal received from the at least one user device.

According to another aspect, there is provided a computer readable medium comprising program instructions which, when executed by an apparatus in a radio access network, cause the apparatus to perform at least the following: selecting at least one user device from one or more candidate user devices as a reference for reference signal time difference, RSTD, measurement; measuring an RSTD between at least two reference signals, wherein the at least two reference signals comprise at least a sidelink positioning reference signal received from the at least one user device selected as the reference; and transmitting, to a network element of a core network, a report comprising at least one of: an identifier of the at least one user device selected as the reference for the RSTD measurement, an identifier of a resource associated with the sidelink positioning reference signal received from the at least one user device, synchronization source information indicating at least one synchronization source of the at least one user device, or a time stamp of the sidelink positioning reference signal received from the at least one user device.

According to another aspect, there is provided a non-transitory computer readable medium comprising program instructions which, when executed by an apparatus in a radio access network, cause the apparatus to perform at least the following: selecting at least one user device from one or more candidate user devices as a reference for reference signal time difference, RSTD, measurement; measuring an RSTD between at least two reference signals, wherein the at least two reference signals comprise at least a sidelink positioning reference signal received from the at least one user device selected as the reference; and transmitting, to a network element of a core network, a report comprising at least one of: an identifier of the at least one user device selected as the reference for the RSTD measurement, an identifier of a resource

In block 602, an RSTD is measured between at least two reference signals, wherein the at least two reference signals comprise at least a sidelink positioning reference signal (SL PRS) received from the at least one user device selected as the reference. For example, the at least two reference signals may further comprise at least one of: a downlink positioning reference signal received from a network element of the radio access network, or a sidelink reference signal received from another user device.

In block 603, a report is transmitted to a network element (e.g., LMF) of a core network, wherein the report comprises at least one of: an identifier of the at least one user device selected as the reference for the RSTD measurement, an identifier of a resource associated with the sidelink positioning reference signal received from the at least one user device, synchronization source information indicating at least one synchronization source of the at least one user device, or a time stamp of the sidelink positioning reference signal received from the at least one user device.

The apparatus may further transmit, to the network element of the core network, a measurement report indicative of the measured RSTD associated with the at least one user device selected as the reference for the RSTD measurement. The measurement report may be transmitted together with or separately from the report mentioned above.

FIG. 7 illustrates a flow chart according to an example embodiment of a method performed by an apparatus such as, or comprising, or comprised in, a network element of a core network. The network element may correspond to the LMF 112 of FIG. 1.

Referring to FIG. 7, in block 701, a report is received from a target user device, wherein the report comprises at least one of: an identifier of at least one user device selected as a reference for measuring a reference signal time difference (RSTD), an identifier of a resource associated with a sidelink positioning reference signal (SL PRS) used for measuring the RSTD, synchronization source information indicating at least one synchronization source of the at least one user device selected as the reference for measuring the RSTD, or a time stamp of the sidelink positioning reference signal used for measuring the RSTD; and

In block 702, a location of the target user device is estimated based at least partly on the report.

The apparatus may further receive, from the target user device, a measurement report indicative of the measured RSTD associated with the at least one user device selected as the reference for the RSTD measurement, wherein the location of the target user device may be estimated based at least partly on the measured RSTD. The measurement report may be received together with or separately from the report mentioned above.

FIG. 8 illustrates a flow chart according to an example embodiment of a method performed by an apparatus such as, or comprising, or comprised in, a user device in a radio access network. The user device may also be called a subscriber unit, mobile station, remote terminal, access terminal, user terminal, terminal device, user equipment (UE), anchor UE, or anchor user device. The user device may correspond to the user device 102 of FIG. 1.

Referring to FIG. 8, in block 801, a threshold value is received from a network element (e.g., LMF) of a core network, wherein the threshold value is for a time difference between receiving a downlink positioning reference signal (DL PRS) and transmitting a sidelink positioning reference signal (SL PRS).

In block 802, the sidelink positioning reference signal is transmitted to a target user device based at least on the threshold value, wherein the time difference between receiving the downlink positioning reference signal and transmitting the sidelink positioning reference signal is less than the threshold value.

The blocks, related functions, and information exchanges (messages) described above by means of FIGS. 3-8 are in no absolute chronological order, and some of them may be performed simultaneously or in an order differing from the described one. Other functions can also be executed between them or within them, and other information may be sent, and/or other rules applied. Some of the blocks or part of the blocks or one or more pieces of information can also be left out or replaced by a corresponding block or part of the block or one or more pieces of information.

As used herein, “at least one of the following: <a list of two or more elements>” and “at least one of <a list of two or more elements>” and similar wording,