(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 632 068 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.08.2013 Bulletin 2013/35

(51) Int Cl.:
H04K 3/00 *(2006.01)*

(21) Application number: **12156957.8**

(22) Date of filing: **24.02.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) **Method of detecting a jamming transmitter affecting a communication user equipment and system, user equipment and communication module**

(57) The invention refers to a method of detecting a jamming transmitter affecting a communication user equipment (UE), wherein said communication user equipment (UE), in particular having a communication module (1), is adapted for communication with a component of a radio network (RN), like a radio network (RN) based on a cellular global system for mobile communications (GSM), having a number of user equipments (UE) and a number of base stations (BS), wherein said method is characterized by:
- providing the user equipment (UE) in a connected mode of a communication radiolink with the component of the radio network (RN); wherein in the connected mode of said user equipment (UE) the steps are provided:
- setting a first, in particular early, power indicator indicative of a received radio signal strength, wherein the early power indicator set is assumed for an unaffected state of the user equipment (UE);
- providing a radiolink evaluation, evaluating whether the communication radiolink is affected by a radiolink error, and wherein
- in case of a radiolink error identification a second, in particular later, power indicator is determined indicative of a received radio signal strength, wherein the second power indicator determined is defined for an affected state of the user equipment (UE);
- comparing the first power indicator to the second power indicator, in particular comparing the early power indicator from a first time (t1) to the later power indicator from a second time (t2),
- indicating a jamming affection in case the comparison shows that the received radio signal strength is unchanged or has increased.

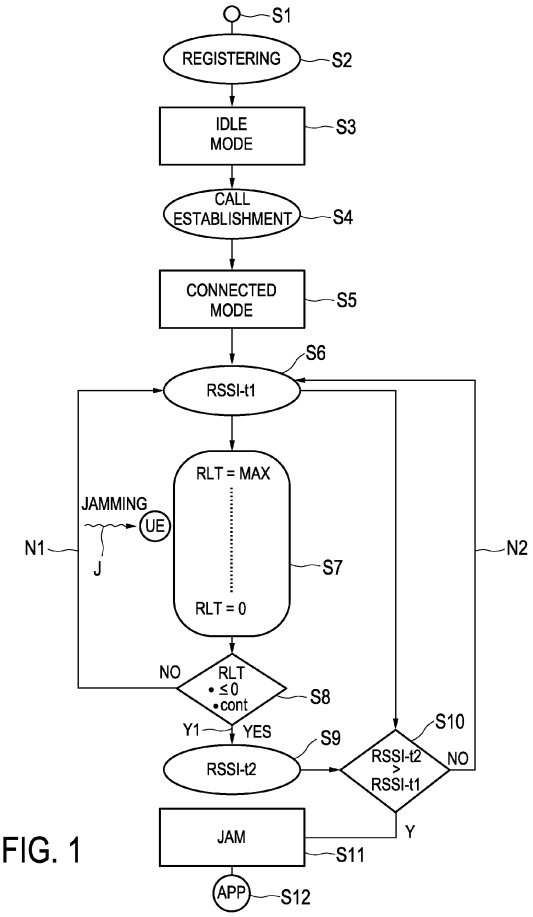

FIG. 1

EP 2 632 068 A1

Description

[0001] A present invention relates to a method of detecting a jamming transmitter affecting a communication user equipment, wherein a set communication user equipment is adapted for a communication with a component of the radio network having a number of user equipments and a number of base stations. The invention also relates to a communication module for a user equipment adapted to execute the method of detecting a user equipment and a jamming transmitter affecting the communication user equipment. The invention also relates to a system comprising the module and an application layer.

[0002] Contemporary, cellular radio networks are known since many years now meanwhile based on different technologies. The broadcast carrier still is held by the global system for mobile communications according to the so called GSM standard. An user equipment in such cellular network can move freely and may be handed over to various cells of the radio networks as e. g. described in GSM standards specification 3GPP ETSI TS51.010 or the like.

[0003] Contemporary, radio networks are based on a cellular code division multiple access (CDMA) as e. g. realized in the universal mobile telecommunication system (UMTS). The latter is increasingly important for security applications like camera systems or the like. Nevertheless, still also the GSM standard is overly important in the majority of security systems or the like.

[0004] Generally, a user equipment in radio networks can be subject of being affected by a jamming transmitter - jamming in this context generally is performed by an instrument preventing a user equipment from receiving signals from its base station. In use the jammer effectively disables cellular phones mostly by broad frequency interference with communication frequencies of the user equipment at high power level. Whereas some jammer applications are meant to be legal for instances in places where phone call is to be suppressed due to silence conditions. Other jammers are applied during misuse for instances to interrupt security applications of user equipment or the like. Jammers are available for jamming GSM and also UMTS frequencies.

[0005] In WO2005/112321 a method for jamming detection in a GSM mobile telecommunications network is described comprising the steps of, at a user equipment registered with the mobile telecommunications network: a) measuring a signal power level in at least one of a plurality of communication channels between the user equipment and a base station within a band of operation of the mobile telecommunications network; b) checking whether the signal power level in said at least one communication channel is greater than a threshold MNPL and, if so, attempting to decode a Base Station Identity Code BSIC broadcast by the base station in said communication channel; c) repeating steps a) and b) for a certain number of channels; d) signaling a jammed condition report JDR message to the base station if said BSIC cannot be decoded for said number DCMN of channels. This method suffers from the fact that usually a signaling of a jammed condition report JDR message to the base station is not possible due to the jammed condition; thus the jammed condition remains unanswered.

[0006] A further anti-jamming solution is known from WO 2007/019814 which is restricted to the GSM standard. Therein a method for detecting a jamming transmitter affecting a communication terminal is described wherein receipt radio-channel signal levels are evaluated at periodic intervals on a signaling channel. In the case that the communication terminal detects a radio-channel signal level that exceeds a predefined threshold value in the signaling channel but is nevertheless unable to decode a message content of a message, then this state is interpreted as an interference state and an alarm signal is emitted.

[0007] However, all the above mentioned approaches suffer from the fact that a jamming situation can only be detected rather than prevented. However, jamming preventing solutions are highly desirable for both GSM and UMTS standards, in particular against GSM jammers. In this regard, it should be recognized that primary aim of an anti-jamming solution is to undoubtedly detect a jamming attack but nevertheless preventing the same shall be possible as well. At least a rather early detection of a jamming attack can help to prevent the same.

[0008] Usually, jamming results in a user equipment loosing connection to the base station; thus camping of a user equipment in the certain cell is no more possible. Technically speaking, the user equipment falls back from a connected mode to an idle mode. An idle mode of a user equipment according to the GSM standard is e. g. described in 3GPP ETSI TS 45.008.

[0009] The above jamming approaches have the aim to detect a jamming situation only in the idle mode. It is known for instance from technical specification 3GPP ETSI TS23.022 that the idle mode still preserves certain operations as the user equipment is still registered in the radio network, that is when the user equipment (also referred to as a mobile station MS) is switched on but has no dedicated channel allocated. Thus, the mobile station is not able to make or receive a call.

[0010] In particular certain idle mode tasks are still possible to provide a radio subsystem link control as it is described in technical specification 3GPP ETSI TS45.008 chapter 6. As outlined above, a jamming detection in the idle mode is rather late and thus limits the chances to prevent a jamming situation.

[0011] This is where the invention comes in, the object of which is to provide an improved method of detecting a jamming transmitter affecting a communication user equipment. In particular it is an object of the invention to provide a method of detecting a jamming transmitter rather early, in particular prior that the user equipment falls back into the idle mode. A further object of the invention is to provide an improved communication module, in par-

ticular user equipment, adapted to execute the method of detecting a jamming transmitter affecting the communication user equipment, in particular to detect the jamming situation already whilst the communication user equipment is in a connected mode; preferably before the connection breaks down. In particular the method and the communication module shall be adapted to detect a jamming warning before a jammed situation is to be accepted; in particular it shall be discriminated between an out of service state of the user equipment and a jamming warning situation.

[0012] As regards the method, the object is achieved by the method of the invention as claimed in claim 1. The method and developed configurations thereof as outlined above may be implemented by digital circuits of any preferred kind, whereby the advantages associated with the digital circuits may be obtained. In particular one or more method steps and/or features of the method can be implemented by one or more means for functionally executing the method step. A single processor or other unit may fulfill the functions of several means recited in the claims - this in particular holds for user equipment according to the concept of the invention.

[0013] The invention also leads to a system of a communication module and an application layer, in particular an user equipment, as claimed in claim 16. The invention also leads to a communication module as claimed in claim 17.

[0014] Preferably said communication user equipment and a number of base stations are components of a radio network, in particular based on a cellular global system for mobile communications (GSM).

[0015] The invention starts from the consideration that instant approaches for detecting a jamming situation are based on measurements at a mobile station (user equipment UE) in the idle mode. The instant invention recognized that nevertheless it is also possible to find sufficient indication for a jamming situation when the user equipment is in a connected mode of a communication radiolink to a component of the radio network; thus wherein during the connected mode the user equipment has a dedicated channel allocated. So to say, the instant invention starts from the recognition that a jamming detection already is possible in a status where the mobile station has a dedicated channel allocated; thus is able to make or receive a call. Advantageously this approach allows for detecting a jamming attack even during a call or connection, i. e. an in-call/connection jamming detection concept is provided.

[0016] Consequently, the method is characterized by providing the user equipment in a connected mode of a communication radiolink to a component of the radio network. More precisely, the method provides a basis to observe the impact of the jammer, respectively jamming power, on an existing radiolink. Preferably the user-equipment indeed can be in an active-status, i. e. is switched on. Consequently, the method preferably further is characterized by providing the user equipment in an active-status, respectively switched on.

[0017] In this kind of or the like status, the method according to the invention provides the steps as further defined in claim 1; in short terms:

- setting a first power indicator indicative of a received radio signal strength, which is assumed for an unaffected state of the user equipment
- evaluating whether the communication radiolink is affected by a radiolink error, in particular a radiolink-failure,
- comparing the first power indicator with the second power indicator and
- indicating a jamming affection in case the comparison shows that the received wide band radio signal strength is unchanged or has increased.

[0018] Preferably the first power indicator is set before the second power indicator, in particular before evaluating whether the communication radiolink is affected by a radiolink error. Nevertheless, it can be useful also to set the first power indicator even during evaluating whether the communication radiolink is affected by a radiolink error as soon as it can be assumed that the first power indicator somewhat reflects a situation wherein the user equipment is not totally blocked by a jamming transmitter. In a first preferred variant it is preferred to define a signal strength level of a suitable cell according to an average value, experience value and/or the like best estimate value for usual undisturbed operation or the like. Thus a measurement of a first power indicator can be omitted by using considerable assumptions about usual unaffected situations. However, nevertheless in a second preferred variant an early power indicator can be set by measuring an early power indicator, in particular at a first time (t1), indicative of a received radio signal strength.

[0019] In short terms a power indicator indicative of a received radio signal strength, in particular over the used radiofrequency of the communication user equipment (UE) is determined in a state of the user equipment which can be assumed to be undisturbed. In particular the communication user equipment is assumed to be undisturbed, in the case a radiolink-timeout counter or another scoring counter has a value above an upper threshold value, which is below a maximum value. Preferably the power indicator at this --in particular early-- point of first time is stored or held in a similar way. Further firstly it is evaluated whether the communication radiolink is affected by a radiolink error. A radiolink error is assumed to enclose any kind of disturbance of the radiolink which can be measured or determined actually.

[0020] Preferably, the first time is before a radiolink evaluation and the second time is during or after the radiolink error identification, and wherein in case of the radiolink error identification the early power indicator determined at the first time before the radiolink error identification is compared to the later power indicator determined at the second time after the radiolink error identi-

fication. A situation during the radiolink error identification e.g. can be assumed in the case the radiolink-timeout counter or another scoring counter has a value below an upper threshold value, in particular which is below a lower threshold value.

[0021] In case of a radiolink error identification an early power indicator determined at a first time before the radiolink error identification is compared to a later power indicator determined at a second time after the radiolink error identification. Thus according to the concept the later power indicator determined at a second time after the radiolink error identification is determined whilst still the connected mode exists; in other words before a radiolink-failure which involves a broken connection. A jamming affection is indicated in case the comparison shows that the received wide band radio signal strength is unchanged or has increased from the first time to the second time.

[0022] The concept of the invention thus has an advantage overcoming solutions wherein a jamming detection is possible only in the idle mode or even only in the out of service mode. Instantly, the concept provides a method for detecting a jamming situation in-call/connection, that is to say, already when a dedicated channel is allocated for the mobile station a jamming situation or an approach of a jamming situation can be detected. This has the advantage that a camera or other security systems can provide a better performance. An anti-jamming detection is rather quick and countermeasures can be provided in a broader and earlier range.

[0023] For instance according to a known approach, a jamming detection is based on detecting that no cell can be received (BCCH) although a high RSSI level is measured. But in a jamming situation a mobile station will at first loose the connected mode of a communication radiolink and will than fall back into the idle mode. Subsequently, the mobile station will have to provide a band or channel search and only in the case this search is not successful a jamming situation can be assumed. In this stadium the mobile station might already be in the out of service situation. This is disadvantageous as it takes time to identify a jamming situation. However time is a valuable parameter in security applications like camera systems or the like.

[0024] By determining a power indicator and evaluating a radiolink error in the connected mode, i. e. in-call/connection, the concept of the invention is able to indicate a jamming situation already when the user equipment still is functioning in a connected mode, although the radiolink in the connected mode is already endangered. This will in particular be possible in a preferred development before a radiolink timeout counter has reached a first threshold value, which is not the lowest threshold, like above zero or the like; i. e. before a (total) radiolink failure with broken connected mode. Thus, there is a good chance that the mobile station or user equipment will be able to safely submit a jamming warning; early countermeasures then can be taken successfully to prevent further continuation of the jamming attack.

[0025] These aspects of the invention and further developments thereof are further outlined in the dependent claims. Thereby the mentioned advantages of the proposed concept are even more improved.

[0026] Preferably a power indicator can be any suitable parameter which is directly measurable or can be deduced from a measurable parameter. In particular the received radio signal strength is a received wide band radio signal strength over the used radiofrequency of the communication user equipment. In particular in the communication module the power indicator is an indicator for a downlink power; preferably the power indicator is or can be deduced from an unbiased downlink power indicator like a received signal strength indicator (RSSI) or the like.

[0027] Generally it is preferred that a jamming affection is indicated to an application layer to perform also evaluation functions. An application layer can be interfaced to and/or integrated in a communication module. In particular in a user equipment an application layer can be interfaced to the user equipment; e.g. by means of an interface apart from the communication radiolink by connection of the communication module and the application layer. In a variant the communication module can be adapted to perform also evaluation functions in an application layer integrated in the module.

[0028] In a preferred development, of course, preferably to provide the radiolink evaluation, it is evaluated whether the communication radiolink is affected by a radiolink-failure, and wherein in case of a radiolink-failure identification

- the early power indicator determined at the first time before the radiolink-failure identification is compared to a later power indicator determined at a second time after the radiolink-failure identification, and
- a jamming affection is indicated in case the comparison shows that the received wide band radio signal strength is unchanged or has increased from the first time to the second time.

[0029] Thus, at least, in the development a jamming affection is indicated due to indicating a radiolink-failure once a second counter-threshold is passed, in particular indicating a radiolink-failure once the scoring-counter falls below the second counter-threshold, e. g. the lowest counter-threshold like zero or the like. Although the development takes in to account the possibility of a broken connected mode, nevertheless a jamming indication can be given early, in particular given immediately before an idle mode.

[0030] As mentioned above a radiolink error is assumed to enclose any kind of disturbance of the radiolink which can be measured or determined actually. A radiolink error in particular can be identified due to one, in particular a number of radiolink-irregularities e.g. due to

a broken block and/or broken link and/or. A rather severe kind of a radiolink irregularity is a radiolink failure, wherein a radiolink-failure is identified due to a fully decremented radiolink-failure timeout counter. A radiolink error identification in the method thus is possible on basis of any radiolink irregularity, in particular a radiolink-failure or another radiolink irregularity. Thus, a radiolink error can be specified according to a rather sensitive setting, namely any radiolink irregularity, in particular arising from a failure to receipt a sent test message, e.g. on a SACCH. Consequently, in case of an early power indicator exceeding a later power indicator an early jamming evaluation can be given well before a totally broken connection due to a radiolink-failure wherein a radiolink timeout counter already has reached a timeout-value.

[0031] Further developed configurations of the invention are further outlined in the dependent claims. Thereby, the mentioned advantages of the proposed concept are even more improved.

[0032] In a particular preferred development determining the power indicator and evaluating the radiolink error, in particular any kind of a radiolink-failure or irregularity, in combination is repeated in a predetermined time sequence. Advantageously, this or other kind of repetition in a loop practically allows a steady supervision of a user equipment against a jamming attack.

[0033] In a preferred development the power indicator is an indicator for a downlink power like an incident downlink power spectral density. A preferred indicator is an unbiased downlink power indicator like a received signal strength indicator RSSI or the like. The development recognized that by measuring an unbiased received wide band power within a band width of the communication user equipment receiver at the communication user equipment antenna connector a basis is given to provide further information about a jamming situation. In particular, by verifying the condition that the power indicator is unchanged or has increased from the first time to the second time, the development is able to provide the basis for making a statement about an in-call/connection jamming situation. In particular, if the unbiased indicator changes significantly the statement can be made.

[0034] In particular the indication can be given to an application layer of an evaluation unit which interfaces to the user equipment. By means of the evaluation unit it is possible to provide information discriminating between a jamming situation and an out-of-coverage-situation. This kind of information can be signalized to a user. A user can be a person or an automatic environment like an alarm or a supervision environment, in particular in mobile entities like a car for instance. Thus, for instance a person driving a car can be warned that at a certain location no alarm or supervision function can be achieved by the user equipment be that it may be due to a jamming situation or be that it may be due to an out-of-coverage situation. As follow-up the information to the automatic or personalized periphery by means of the evaluation unit can be used to provide further measures which are adapted to the kind of loss of service availability. For instance other alarm or supervision functions can be activated. For instance the situation can be used to save energy by cutting off a process which is not of use in an out-of-coverage situation.

[0035] A power indicator is considered as any parameter significant for a power. This, of course comprises a physically measurable power quantity itself, but also comprises any other value which is of use to denote quantitatively the power quantity. In particular the parameter not necessarily needs to have the metric unit of a power but can be a dimensionless quantity, in particular a ratio or logarithmic or bit-value or other value, which is suitable to quantitatively describe the physical power quantity.

[0036] In particular the meaning of power is to be understood broadly and also comprises the meaning of energy. A preferred understanding of power is power spectral density (PSD) according to the standard, whereas the units of Power Spectral Density (PSD) are extensively and of broader use in this application. Generally a PSD is a function of power versus frequency and when integrated across a given bandwidth (like a channel e. g.); the function represents the mean power in such a bandwidth. When the mean power is normalized to (divided by) the chip-rate it represents the mean energy per chip. This is the common practice of relating power and energy or the like magnitudes in communication systems. It can nevertheless be seen that if both energy magnitudes in the ratio are divided by time, the ratio is converted from an energy ratio to a power ratio, which is more useful from a measurement point of view. It follows that an energy per chip of X dBm/200kHz can be expressed as a mean power per chip of X dBm. Similarly, a signal PSD of Y dBm/200kHz can be expressed as a signal power of Y dBm.

[0037] In a particular preferred development a radiolink error is identified with a single radiolink irregularity or a sequence of irregularities e.g. two or three radiolink irregularities, in particular low number of radiolink irregularities. Basically, a radiolink error, in particular irregularity, can be measured by any suitable means. For instance a radiolink irregularity can be measured by sending a testmessage or another kind of radiolink-information item, either for test purposes only or also using usual sending of other messages or another kind of radiolink-information item, e. g. a paging message or a channel signal the like. Subsequently a missing receipt or non-decodability of the testmessage or other message can be detected. Particular preferred, a radiolink-failure identification is performed by:

- repeatingly decoding a radiolink-information item indicative of the connected mode of the radiolink,
- scoring the able to decode and unable to decode incidence rate,
- indicating a radiolink error once an upper threshold of a radiolink timeout counter or the like first early countermeasure is passed.

[0038] Preferably a radiolink error, e.g. a irregularity, can be indicated once a first counter decrement, in particular a first counter-threshold is passed. In particular a radiolink error can be indicated once the scoring-counter falls below the first counter-threshold. In particular a radiolink-failure can be indicated once a second counter-threshold is passed. Preferably a radiolink-failure can be indicated once the scoring-counter falls below the second counter-threshold. The latest development provides indicating a radiolink-failure once a limit second countermeasure is passed. Thus, a radiolink-failure is identified due to a high number of radiolink irregularities.

[0039] Of course, also other scoring rules can be provided. However it has been considered to be advantageous to provide a scoring rule, which can be easily implemented in a standard; like for instance the technical specification GSM ETSI TS0508 chapter 5. Therein, a particular preferred scoring-counter is described in form of a radiolink timeout counter (RLT). Using the radiolink timeout counter is considered to be particular advantageous for identifying a radiolink error and/or a radiolink-failure. In particular, therein a radiolink-testmessage is a testmessage sent on a slow associated control channel SACCH. Nevertheless, generally a radiolink-testmessage can also be a testmessage on any control channel CCH. On the other hand --for detecting a jamming situation-- the instant development distinguishes basically from approaches using paging messages on a PCH channel or another message on a TCH channel, as these are only suited to serve as a basis in an idle mode, whereas the instant development is based on detecting a jamming situation already in the connected mode of a radiolink.

[0040] The RLT counter based on the downlink SACCH in 3GPP ETSI TS05.08 is only one example of a scoring-counter based on a control channel. Generally, as scoring-counter can indicate a radiolink-failure once the scoring-counter falls below a counter threshold. For instance, additionally the scoring-counter can be checked whether it decrements or increments continuously. This is an advantageous further condition for safely indicating a jamming situation. Generally, it is advisable to provide the radiolink error and/or -failure identification based on an unable-to-decode incidence scoring negative and an able-to-decode incidence rate scoring positive wherein the scoring-counter has a positive start threshold and a counter threshold is zero.

[0041] Of course, also further regularities can be determined with a selected scoring rule. For instance a strong indicator for an upcoming radiolink-failure, i. e. existing radiolink error, is present in the case a consecutive sequence of radiolink-irregularity, in particular a consecutive sequence of radiolink errors is determined. In this case a radiolink timeout counter may not have reached a second threshold limit, but still nevertheless the consecutive sequence can be sufficient to give a safe extrapolation, that (and possibly also when) a radiolink-failure is to be expected. Thus providing regularity with a scoring rule is advantageous to detect a radiolink-failure before the radiolink-failure occurs, in particular before a second late countermeasure or limit countermeasure is passed. E.g. a preferred embodiment as described with the drawing can be used, wherein a lower and a upper threshold value of a radiolink timeout counter serve as suitable countermeasures.

[0042] The instant concept and the developed configuration thereof are particularly advantageous in a radio network based on a cellular global system for mobile communications. However, nevertheless equivalent measures according to the concept can also be used in a CDMA based radio network like an UMTS network for detecting an in-call/connection jamming situation.

[0043] For a more complete understanding of the invention, the invention will now be described in detail with reference to the accompanying drawing. The detailed description will illustrate and describe what is considered as a preferred embodiment of the invention. It should of course be understood that various modifications and changes in form or detail could readily be made without departing from the spirit of the invention. It is therefore intended that the invention may not be limited to the exact form and detail shown and described herein, nor to anything less than the whole of the invention disclosed herein and as claimed hereinafter. Further the features described in the description, the drawing and the claims disclosing the invention may be essential for the invention considered alone or in combination. In particular, any reference signs in the claims shall not be construed as limiting the scope of the invention. The wording "comprising" does not exclude other elements or steps. The wording "a" or "an" does exclude a plurality.

[0044] In the drawing:

Fig. 1: shows a flow chart for a first embodiment of a method of detecting a jamming transmitter affecting a communication user equipment in course of a radiolink-failure;

Fig. 2: shows a flow chart for a second embodiment of a method of detecting a jamming transmitter affecting a communication user equipment in course of a radiolink error;

Fig. 3: shows a flow chart for a further adapted second embodiment of a method of detecting a jamming transmitter affecting a communication user equipment in course of a radiolink error;

Fig. 4: shows a preferred embodiment of a user equipment adapted to execute the method of detecting a jamming transmitter affecting the communication user equipment as shown in Fig. 1.

[0045] Fig. 1 shows a preferred embodiment of a method of detecting a jamming transmitter affecting a communication user equipment wherein the user equipment

is activated in step S1, namely by switching on the user equipment to an active-status. In step S2 the user equipment is registering in the radio network, which in the present case is a GSM network (global systems for mobile communication). As described in the standard, thereafter the user equipment will approach from the out of service situation after registering to the idle mode in step S3, wherein the user equipment is switched on but has not yet a dedicated channel allocated. Thus, in the idle mode in step S3, the user equipment is able to make or receive a call but does not have an active call. In step S4 a call establishment is done, i.e. the user equipment receives or originates a call and once parameters are made as outlined in 3GPP TS45.008, the communication module will approach to the connected mode in step S5; then the communication module will have an active call on a dedicated channel, which has been allocated during step S4. For technical systems like security systems, wherein signals, e. g. camera data or the like, are transmitted by means of a communication module in the system, the signals can be transmitted in the dedicated connection or channel of the connected mode of the communication radiolink.

[0046] The further flow chart indicates measures, which can steadily be provided in a predetermined time sequence or loop by the communication module. For better illustration, in the instant example the measures are described for a process of a jamming situation, wherein a jamming signal J is affecting the user equipment UE. In the instant embodiment in a predetermined time sequence a power indicator --here the so called received signal strength indicator RSSI-- is measured as an early power indicator and is determining at a first time t1 as a received wide band radio signal strength over the radio frequency band width of the antenna of the communication user equipment. Here, the early power indicator RSSI-t1 in step S6 is determined at the first time t1; thus well before in step S8 a radiolink-failure identification happens, due to the continued jamming action indicated along with step S7.

[0047] The received signal strength indicator RSSI measured at the first time t1 to determine the early power indicator RSSI-t1 can be stored or held by any suitable means as the early power indicator. Thus the early power indicator is available for later on comparison and contains a received signal strength indicator RSSI measured for an undisturbed situation of the user equipment at the first time t1.

[0048] The radiolink-failure identification in step S8 of the instant embodiment is prepared by decrementing --due to the jamming signal J-- a radiolink timeout counter RLT. The radiolink timeout counter RLT is decremented continuously from a maximum value MAX to or below a counter-threshold, which is referenced by a value 0. Thus, in particular, as described in GSM ETSI TS05.08 chapter 5.2, here due to the jamming signal J the mobile station will be unable to decode a SACCH message and thus, the scoring counter in form of the radiolink timeout counter RLT is decreased by a value of 1 (in this case a parameter of Bad Frame Indication BFI=1; SACCH stands for Slow Associated Control Channel). In the case of a successful caption (not the case here) of a test message in form of a SACCH message (Bad Frame Indication BFI=0) the radiolink timeout counter RLT value S is increased by a value of 2. In any case the radiolink timeout counter shall not exceed the value of low radiolink timeout which is S=0. If, however, the radiolink timeout counter RLT reaches S=0 or is even below 0 a radiolink-failure is indicated in step S8. Additionally, in this embodiment, the condition is checked whether the radiolink timeout counter RLT has been decremented continuously; it is further checked whether a parameter "cont" is positive. This advantageously allows preventing instrument errors and excludes detection alarms which merely arise from a swaying radiolink situation. Thus in the present embodiment the radiolink-failure identification reliably is established by a radiolink timeout counter RLT with a value S equal to or below 0 and a positive parameter "cont". A further action can be specified as described in GSM ETSI TS04.18 and the radiolink timeout parameter can be transmitted by each BSS (Base Station System) in the data of the BCCH (Broadcast Control Channel) and the mobile station MS or other kind of user equipment UE shall continue transmitting as normal on the uplink until the value S reaches 0. The algorithm of a further action shall start after the assignment of a dedicated channel and the value S shall be initialized to a value of the radiolink timeout counter. The detailed operation is outlined in GSM ETSI TS05.08 chapter 5.2. This is the case for the NO-path N1 starting from step S8 and the NO-path N2 starting from step S10.

[0049] However, in the present case --in step S9 following the YES-path Y1-- a further determination of a later power indicator RSSI-t2 at a second time t2 after the radiolink-failure identification in step S8 is performed. Thus, two power indicators are available; an early power indicator RSSI-t1 from step S6 --not influenced by the jamming signal J-- and a later power indicator RSSI-t2 from step S9 --influenced by the jamming signal J--. In step S10 the further condition is verified whether the received wide band radio signal strength RSSI is unchanged or has increased from the first time t1 to the second time t2. In the present case it is sufficient to compare the RSSI values RSSI-1t1 and RSSI-t2, namely the early power indicator RSSI-t1 and the later power indicator RSSI-t2 directly. In the case that in step S10 the later power indicator RSSI-t2 is greater or equal to RSSI-t1, a jamming situation is indicated in step S11. The jamming situation JAM can be indicated to an application APP in step S12. Thus, even in the case that a connected mode shall already be interrupted by the jammer due to the jamming signal J (as described here)still nevertheless-- a messaging by a software-interface or the like is possible to an application APP informing about the jamming situation JAM. Thus, warnings about the jamming situation JAM can be given from another side of a higher

system. A user or supervisor of the higher system level can be warned by the messaging in that jamming occurs and that a correct functioning of a security system cannot be guaranteed.

[0050] It should be recognized that in the present embodiment for the radiolink evaluation primarily it is evaluated whether the communication radiolink is affected by a radiolink-failure, wherein a radiolink-failure identification is identified due to a fully decremented radiolink timeout counter RLT to a minimum value S=0 at least.

[0051] However, --as is exemplified in Fig. 2-- in an elaborated further developed embodiment for the method it can be evaluated whether the communication radiolink is affected by a radiolink-irregularity, wherein a radiolink-irregularity identification is identified due to a radiolink timeout counter RLT decremented below a lower threshold value S=LOW, which is above the aforementioned minimum value S=0. The lower threshold value can be defined such that the lower threshold value S=LOW is below an upper threshold value S=UP. In particular the communication user equipment UE can be assumed to be undisturbed, in the case a radiolink timeout counter RLT has a value S above an upper threshold value S=UP, which nevertheless is below a maximum value S=MAX. It turned out, that is advantageous to provide such kind of smooth threshold values apart from the minimum and maximum values, such that an early jamming evaluation or warning can be provided. The upper threshold value S=UP and the lower threshold value S=LOW or other kind of smooth threshold values of the radiolink timeout counter can be adapted e.g. due to a statistical analysis of radiolink signals or operational situations adapted to the instant location and surrounding of the user equipment (UE).

[0052] Fig. 2 shows a more elaborated exemplifying embodiment of a method of detecting a jamming transmitter affecting a communication user equipment UE in course of one or more radiolink-irregularities, preferably wherein a radiolink-irregularity is identified due to a broken block and/or broken link and/or a fully decremented timeout counter identifies a radiolink-failure. In these and other cases --depending on a specific setting a radiolink error is identified due to a jamming signal J.

[0053] The more elaborated second embodiment of a method of Fig. 2 starts in a first step SE1 wherein the user equipment UE is in a connected mode. In a subsequent step SE2 the radiolink timeout counter RLT is set to its maximum value MAX. As an instant follow-up in step SE3 one can be sure that the RLT counter indeed has the maximum value S=MAX. A power indicator parameter --here an RSSI-value RSSI-t1 at a first earlier point of time t1-- is acquired and hold; for instance by storing in a storing medium of or connected to a communication module in the user equipment UE. A measurement or other setting of a power indicator parameter in exceptional situations can be affordable even when the RLT counter has not the maximum value S=MAX, but is e.g. at least above a value above an upper threshold value S=UP. Nevertheless it should be avoided to set a power indicator parameter when the RLT counter has not the maximum value S=MAX. This makes sure that the first earlier power indicator RSSI-t1 is taken preferably in an undisturbed state of the user equipment UE. At least this assures that the comparative value of an RSSI power indicator is at a sufficient high level to be compared to a later power indicator RSSI-t2 determined at the later second time t2. In particular the communication user equipment UE can be assumed to be less disturbed, --at least in a smoothed setting-- in the case a radiolink timeout counter RLT has a value S above an upper threshold value S=UP, which nevertheless is below a maximum value S=MAX. Also recognition that a radiolink timeout counter RLT has a value S above an upper threshold value S=UP can be used to suppress signaling of a jamming warning due to the assumption that as soon as S is above an upper threshold value S=UP a warning is to be considered as too early in the specific situation.

[0054] At this early point of first time t1 with preferably S=MAX or at least S> UP --important for a later stadium of the method-- the further procedural sequence is followed up by step SE4 directly, namely by evaluating the radiolink; e.g. by sending a test message on the SACCH as described above. In the case such or another predefined kind of radiolink irregularity is acknowledged during radiolink evaluation in step SE4 a radiolink error can be indicated in step S5. It should be recognized that the radiolink-failure described with the embodiment of Fig.1 is only one exemplifying item of a radiolink irregularity, which --of course can also be define to be of minor severity. Generally a radiolink error identification in step SE5 thus is possible on basis of any radiolink irregularity according to the general part of these application documents, in particular well before a radiolink-failure is detected as outlined in the above description of Fig. 1.

[0055] Here, as a follow-up of a radiolink irregularity in the YES-path YE1 the RLT counter is decremented in step SE6. At the second later point of time t2 the further later power indicator RSSI is measured in step SE7 as RSSI-t2. This procedure makes sure that the later power indicator RSSI-t2 at the second point of time t2 is measured already in a rather early stadium of radiolink irregularity, namely already just after the occurrence of a first radiolink-irregularity. In particular --at least in a smoothed setting-- a radiolink-irregularity identification is identified due to a radiolink timeout counter RLT decremented below a lower threshold value S=LOW, which is above the aforementioned minimum value S=0. The lower threshold value can be defined such that the lower threshold value S=LOW is below an upper threshold value S=UP.

[0056] Thus, according to the developed further elaborated method shown in Fig. 2 the sequence of steps SE5, SE6 and SE7 makes sure that an early jamming evaluation warning of Step SE16 is possible already right after the occurrence of a first radiolink irregularity. Thus, here a radiolink error is specified according to a rather sensitive setting, namely any radiolink irregularity, in par-

ticular arising from a failure to receipt a sent test message on a SACCH. In case of an RSSI-t2-value exceeding an RSSI-t1-value in step SE8 an early jamming evaluation can be given in step SE9 well before a totally broken connection due to a radiolink-failure as described with Fig.1 wherein the radiolink timeout counter already has reached the value S=0.

[0057] Consequently as compared to the method shown in Fig. 1 the instant elaborated method is able to provide an early jamming warning following the step SE9 and SE16 well before a totally broken connection and thus earlier than the embodiment described in Fig. 1.

[0058] In particular if a sequence of RLT counter decrements is evaluated by the "Early Jamming Detection" in SE9 a more reliable Early Jamming warning level and/or state will result.

[0059] Consequently if after RLT counter being decremented one RLT counter increment or a sequence of RLT counter increments is evaluated in SE9 the Early Jamming warning level can be decreased and/or the warning state can be switched off.

[0060] In a modified embodiment which is not shown in detail in Fig. 2 the measurement of RSSI-t1 in step SE3 can be replaced by a setting of an early power indicator according to a best estimate value for a suitable cell. This allows a saving of energy consumption in a module. Thus an early jamming warning in step SE16 in the modified embodiment already is possible once an RLT counter decrement is evaluated in SE9 and a RRSI-t2 is below the best estimate value. Also an estimation of a jamming probability is possible advantageously with taking into account further parameters of an instant situation of the module.

[0061] In the alternative in step SE5 a radiolink error is not indicated (NO-path NE1) the radiolink timeout counter RLT is incremented in step SE10. Thereafter in step SE11 it is verified further whether the RLT counter value is below a maximum value S<MAX. In the positive case (YES-path, YE2) the procedure further follows step SE7 as described above. This means the procedure of checking a RSSI power indicator at a later point of time t2 continues until the RLT counter value reaches again the maximum value S=MAX or --at least in a smoothed setting-- reaches the upper threshold value S=UP. Thus, Early Jamming Evaluation in step SE9.is continued until it can be safely assumed that no radiolink irregularity exists. Otherwise following the further NO-path NE2 the radiolink timeout counter RLT is set to its maximum value MAX. As a consequence of this continued assessment an early jamming evaluation will be indicated and given as a warning to the user of a user equipment UE until it can be safely assumed that every radiolink irregularity is omitted; thus until it can be safely assumed that no jamming action occurs anymore.

[0062] In the case in step SE12 the RLT counter value exceeds a minimum value --here the lowest threshold value of S=0 or at least in a smoothed setting reaches the lower threshold value S=LOW also the instant procedure makes sure that an evaluation of a radiolink irregularity continues further with the sequence starting from step SE4 following the YES-path YE3.

[0063] In the alternative in the NO-path NE3 proceeding from step SE12 a broken connection will be indicated in step SE13 and given as an indication of a jamming situation JAM to the user of a user equipment UE. Also, once the RLT counter value is equal to or below 0, an OOS warning can be given in step SE15.

[0064] The instant procedural steps can be performed by a module itself in user equipment itself, wherein an application APP in step SE14 is integrated into the module. Also the application layer can be interfaced to the module in the user equipment UE. The application APP can gather further information and parameters to rate the instant situation; thus is also capable to further modify the indication of a broken connection. Also the application APP is in receipt of an out-of-service warning OOS as depicted in step SE15 and a Jamming warning as depicted in step SE16.

[0065] Fig. 3 describes in more detail what has been indicated before as an embodiment of smoothed setting. A particular preferred further extension of the procedure described with the second embodiment of Fig. 2 can be switched-in between junction items J1 following step SE7 and J2 before step SE12 as depicted in the flow chart of Fig. 2. The extension is preferably used to define application and usage dependent threshold criteria for very early indication of a radiolink error; which is also denoted as a jamming warning. Follow-up junction J1 in step SJ1 various threshold criteria can be defined. For instance it can be defined that a radiolink error is indicated only in the case the RLT counter decrements below a certain first threshold value Y. Here a number of RLT counter values S=RLT1..RLTi..RLTn; i=1-n are defined in Y.

[0066] As a follow-up the early jamming warning of step SE9 is given only in the case the RLT counter has been decremented in step SE6 below the specified threshold value Y. Alternatively or additionally a number X of radiolink irregularities can be specified which define a consecutive sequence of one after the other radiolink irregularities. Here a number of RSSI-t2 values S= RSSI-t2_1.. RSSI-t2_i.. RSSI-t2_n ; i=1-n can be specified. Thus, only in the case a consecutive sequence of for instance a number of X=3..5 radiolink irregularities occurrences in step SE6 lead to an indication of an early jamming warning of step SE9 as indicated.

[0067] Thus, dependent on the definition of threshold criteria in step SJ1 the conditions given in step SJ3 and SJ2 are checked. In case an analysis of an RLT irregularity is of sufficiently severe result in step SJ3 the further procedure can reveal in step SJ2 that the RSSI-t2-value exceeds the RSSI-t1-value. In this case a jamming probability of step SJ4 can be given in step SJ5 --dependent on the severity of the threshold criteria defined in steps SJ3 and SJ2-- in the YES-path YJ1; otherwise in the case the condition is not fulfilled only a bad radiolink indication is given in step SJ6, in particular step SJ6 can also indi-

cate an out-of-coverage-situation to the user if for example RSSI-t2 < RSSI-t1. A jamming probability indication result of step SJ4 can be given additionally to or alternatively to an early jamming evaluation of step SE9 of the procedure in Fig. 2.

[0068] Consequently a user of the user equipment UE can receive in an elaborated situation not only an early jamming evaluation indication from step SE9 but also an indication of probability of jamming as produced from step SJ7.

[0069] In a preferred embodiment the jamming probability and the early jamming evaluation of steps SJ4 and/or SE9 respectively can be given to an application APP, in particular an application layer 10 as shown in Fig.4. In this case the application layer primarily is adapted to provide further measures like e.g. provide signalling options for giving a jamming indication and/or warning to a user or other layers of a communication system and/or network. In the application layer 10 further measures as follow-up action can be evaluated to be taken or signalized to a user or connected items of the user equipment. Thus in the periphery of the user equipment not only a early jamming evaluation is available but also a probability of jamming so that counter action can be taken at a very early stage of jamming and still usually in a connected mode condition of the user equipment. This situation is depicted by the application layer 10 and user equipment 1.

[0070] In the case the condition checked in step SJ2 is not fulfilled the supplement of the extended procedure is followed to the junction point J2 and continued with step SE12 shown in Fig. 2. Also, if the RSSI-t2-value does not exceed the RSSI-t1-value (NO-path of step SJ3) in-between indication to the user of step SJ5 is suppressed for instance before continuing with junction J2 as outlined above. Thus, in the supplement between junction items J1 and J2 the user receives a bad radiolink warning as long the RLT counter value is above a minimum or low threshold in step SE12.

[0071] In Fig. 4 a user equipment UE is shown wherein a communication module 1, 1' and a connected application layer 10, 10' is provided in the user equipment UE. The communication module 1, 1' is connected via an antenna 11 thus a received wide band radio signal strength can be measured by a power indicator 2 of the communication module. In the present case the power indicator 2 will provide an RSSI value taking into account not only the usual network signal strength but also a strength of the jamming signal J.

[0072] Further a radiolink timeout module 3 is provided, capable of executing the step S7 of the method described in Fig. 1 or similar step SE6 as shown in Fig. 2 and Fig. 3 in the case an early jamming indication is preferred. The radiolink timeout module 3 and the power indicator 2 are started repeatedly for determining the power indicator RSSI; a radiolink-failure evaluation is triggered by a clock 4 or the like sequencing unit.

[0073] The following procedural steps of comparator 5 and unit 6 can be implemented in module 1. In this case, a jamming indication of step S11 can be given to an application 7 connected to the module 1. However, also the module 1' can be adapted only to provide the output of radiolink timeout module 3 and power indicator 2 to an application layer 10'; thus the application layer 10' can be adapted to provide the procedural steps of comparator 5 and unit 6.

[0074] Here, once a zero value S of the RLT counter (i. e. generally a counter threshold of the scoring-counter) is achieved, a comparator 5 is triggered for comparing an early power indicator at a first time t1 and a later power indicator at a second time t2. The difference thereof is provided to an evaluation unit 6 for processing the step S10 of the method of Fig. 1. In the case the result is positive, it can be assumed that the received wide band radio signal strength is unchanged or has increased from the first time t1 to the second time t2.

[0075] Thus, the user of the user equipment UE can be warned of the jamming situation.

Claims

1. Method of detecting a jamming transmitter affecting a communication user equipment (UE), wherein said communication user equipment (UE), in particular having a communication module (1), is adapted for communication with a component of a radio network (RN), like a radio network (RN) based on a cellular global system for mobile communications (GSM), having a number of user equipments (UE) and a number of base stations (BS), wherein said method is **characterized by**:

   - providing the user equipment (UE) in a connected mode of a communication radiolink with the component of the radio network (RN); wherein in the connected mode of said user equipment (UE) the steps are provided:
   - setting a first, in particular early, power indicator indicative of a received radio signal strength, wherein the early power indicator set is assumed for an unaffected state of the user equipment (UE);
   - providing a radiolink evaluation, evaluating whether the communication radiolink is affected by a radiolink error, and wherein
   - in case of a radiolink error identification a second, in particular later, power indicator is determined indicative of a received radio signal strength, wherein the second power indicator determined is defined for an affected state of the user equipment (UE);
   - comparing the first power indicator to the second power indicator, in particular comparing the early power indicator from a first time (t1) to the later power indicator from a second time (t2),

- indicating a jamming affection in case the comparison shows that the received radio signal strength is unchanged or has increased.

2. Method according to claim 1 wherein the received radio signal strength is a received wide band radio signal strength over the used radiofrequency of the communication user equipment (UE), in particular the communication module (1), preferably wherein the power indicator is an indicator for a downlink power, in particular wherein the power indicator is an unbiased downlink power indicator like a received signal strength indicator (RSSI) or the like.

3. Method according to claim 1 or 2 wherein setting an early power indicator is executed by defining a signal strength level of a suitable cell according to an average value, experience value and/or the like best estimate value, in particular at a first time (t1).

4. Method according to any of the claims 1 to 3 wherein setting an early power indicator is executed by measuring an early power indicator determined, in particular at a first time (t1), indicative of a received radio signal strength.

5. Method according to any of the claims 1 to 4 wherein the early power indicator determined at the first time (t1) is compared to a later power indicator determined at a later second time (t2) in particular wherein the first time (t1) is before a radiolink evaluation and the second time (t2) is during or after the radiolink error identification.

6. Method according to any of the claims 1 to 5 wherein the power indicator determination and the radiolink error evaluation in combination, in particular the power indicator determination and the radiolink-failure evaluation in combination, are repeated in a predetermined time sequence.

7. Method according to any of the claims 1 to 6 wherein it is verified that a scoring-counter is changed, in particular continuously changed, due to a number of radiolink-irregularities to identify a radiolink error and/or a radiolink failure.

8. Method according to any of the claims 1 to 7 wherein a radiolink error is identified due to a radiolink-irregularity, in particular a number of radiolink-irregularities, wherein a radiolink irregularity is identified due to a broken block and/or broken link and/or a partially changed, in particular decremented, radiolink timeout counter (RLT).

9. Method according to any of the claims 1 to 8 wherein to provide the radiolink evaluation it is evaluated whether the communication radiolink is affected by a radiolink-failure, wherein a radiolink-failure identification is identified due to a fully decremented scoring-counter, in particular is identified due to a radiolink timeout counter (RLT) decremented to a minimum value (S=0).

10. Method according to any of the claims 1 to 9 wherein the communication user equipment (UE) is assumed to be undisturbed, in the case a scoring-counter, in particular a radiolink timeout counter (RLT), has a value (S) above an upper threshold value (S=UP), which is below a maximum value (S=MAX).

11. Method according to any of the claims 1 to 10 wherein to provide the radiolink evaluation it is evaluated whether the communication radiolink is affected by a radiolink-irregularity, wherein a radiolink-irregularity identification is identified due to a scoring-counter, in particular a radiolink timeout counter (RLT), decremented below a lower threshold value (S=LOW), which is above a minimum value (S=0), in particular wherein the lower threshold value (S=LOW) is below an upper threshold value (S=MAX).

12. Method according to any of the claims 1 to 11 wherein a radiolink-failure identification is performed by:

- repeatingly decoding a radiolink-information item indicative of the connected mode of the radiolink;
- scoring an able-to-decode incidence rate and/or an unable-to-decode incidence rate for a number of radiolink information items on a scoring-counter
- indicating a radiolink error once an erroneous radiolink-information item reception or erroneous link- or block-error or the like disturbed decoding is registered.

13. Method according to any of the claims 1 to 12 wherein an unable-to-decode incidence rate scores negative and an able-to-decode incidence rate scores positive and wherein the scoring-counter has a positive start-threshold and a counter-threshold is zero, in particular wherein a scoring-counter is formed by a radiolink timeout counter (RLT).

14. Method according to any of the claims 1 to 13 wherein a radiolink-information item is a radiolink-testmessage, in particular a testmessage transmitted on a control channel (CCH), preferably a testmessage transmitted on a Slow Associated Control Channel (SACCH).

15. Method according to any of the claims 1 to 14 wherein a jamming affection is indicated to an application layer (10) interfaced to and/or integrated in a communication module (1).

16. System of a communication module (1) and an application layer, in particular a user equipment (UE), adapted to execute the method of detecting a jamming transmitter affecting the communication user equipment (UE) as claimed in any of the preceding claims, in particular wherein the application layer (10) is integrated in the communication module (1) or is interfaced to the communication module (1).

17. Communication module, in particular for implementation into system of claim 16, for providing a user equipment in an active-status and in a connected mode of a communication radiolink with the component of the radio network (RN); wherein the communication module has one or more means for providing the following steps in the connected mode of said user equipment:

- means for determining an early power indicator determined at a first time (t1) and a later power indicator determined at a second time (t2) indicative of a received radio signal strength, in particular over the used radiofrequency of the communication user equipment (UE);
- means for providing a radiolink evaluation, evaluating whether the communication radiolink is affected by a radiolink error, in particular irregularity or failure;
- means for submitting a radiolink error signal and the early power indicator determined at a first time (t1) and a later power indicator determined at a second time (t2) to an application layer.

18. Communication module, in particular for implementation into system of claim 17, wherein an application layer is adapted to provide the following steps in case of a radiolink error identification:

- the early power indicator determined at the first time (t1), in particular determined before the radiolink error identification, is compared to a later power indicator determined at a second time (t2), in particular determined after the radiolink error identification.
- a jamming affection is indicated in case the comparison shows that the received wide band radio signal strength is unchanged or has increased from the first time (t1) to the second time (t2).

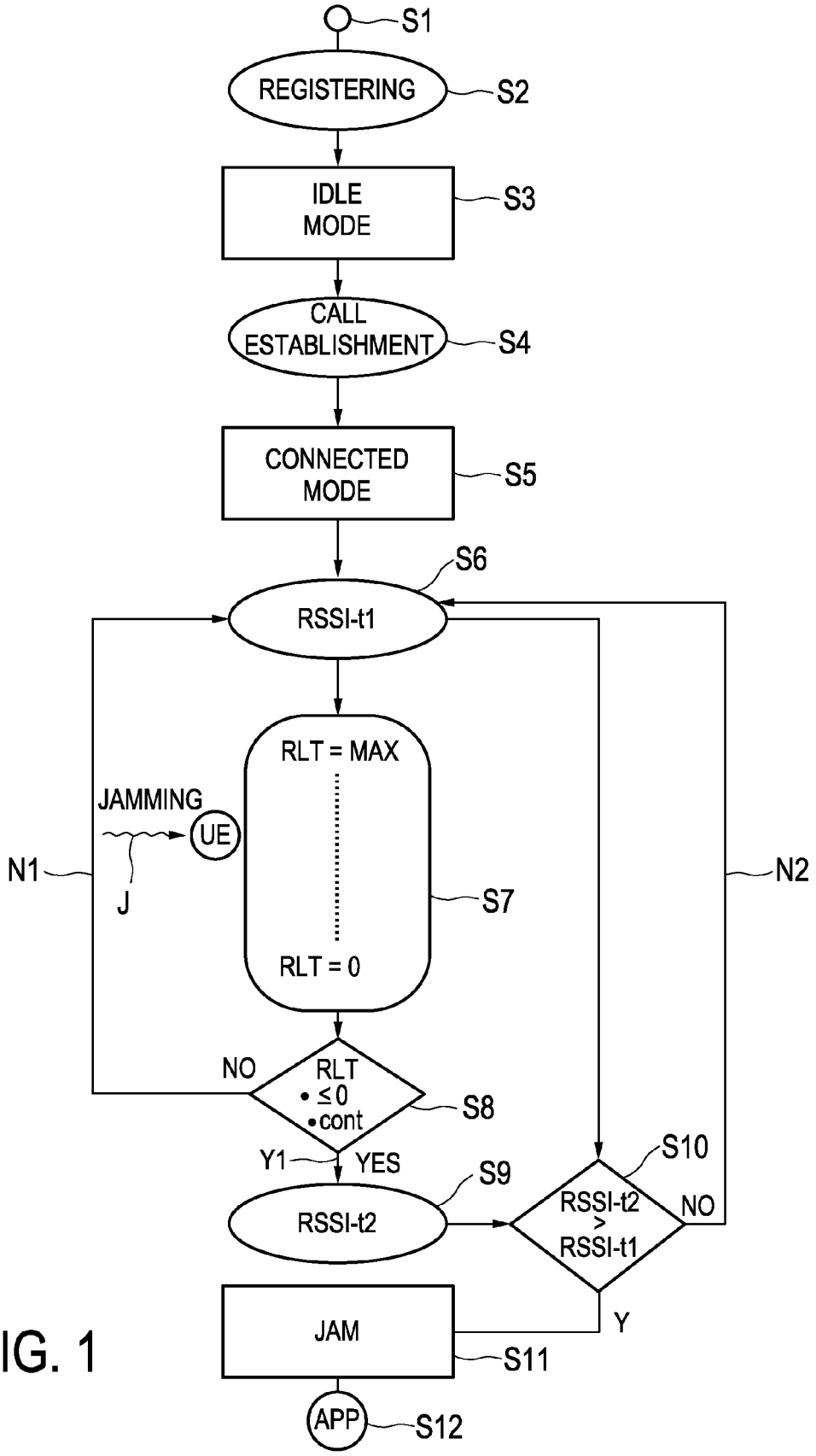
S1
REGISTERING
S2
IDLE MODE
S3
CALL ESTABLISHMENT
S4
CONNECTED MODE
S5
S6
RSSI-t1
RLT = MAX
JAMMING
UE
N1
J
S7
RLT = 0
N2
NO
RLT
• ≤ 0
• cont
S8
Y1
YES
S9
RSSI-t2
S10
RSSI-t2 > RSSI-t1
NO
Y
JAM
S11
APP
S12

FIG. 1

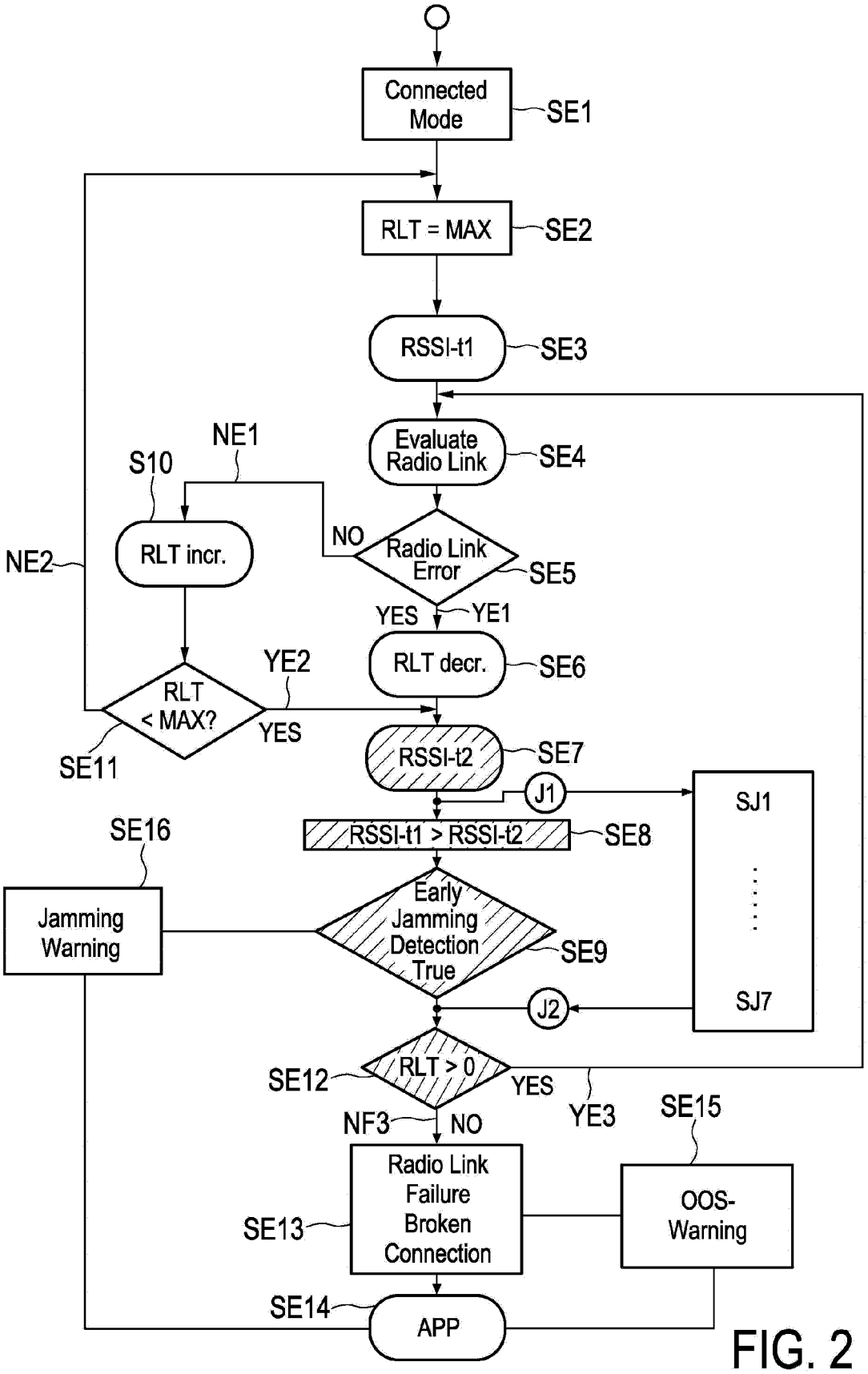
Connected Mode
SE1
RLT = MAX
SE2
RSSI-t1
SE3
Evaluate Radio Link
SE4
NE1
S10
NO
Radio Link Error
SE5
NE2
RLT incr.
YES
YE1
RLT decr.
SE6
YE2
RLT < MAX?
YES
SE11
RSSI-t2
SE7
J1
SJ1
SJ7
SE16
RSSI-t1 > RSSI-t2
SE8
Jamming Warning
Early Jamming Detection True
SE9
J2
SE12
RLT > 0
YES
YE3
NF3
NO
SE15
Radio Link Failure Broken Connection
SE13
OOS-Warning
SE14
APP

FIG. 2

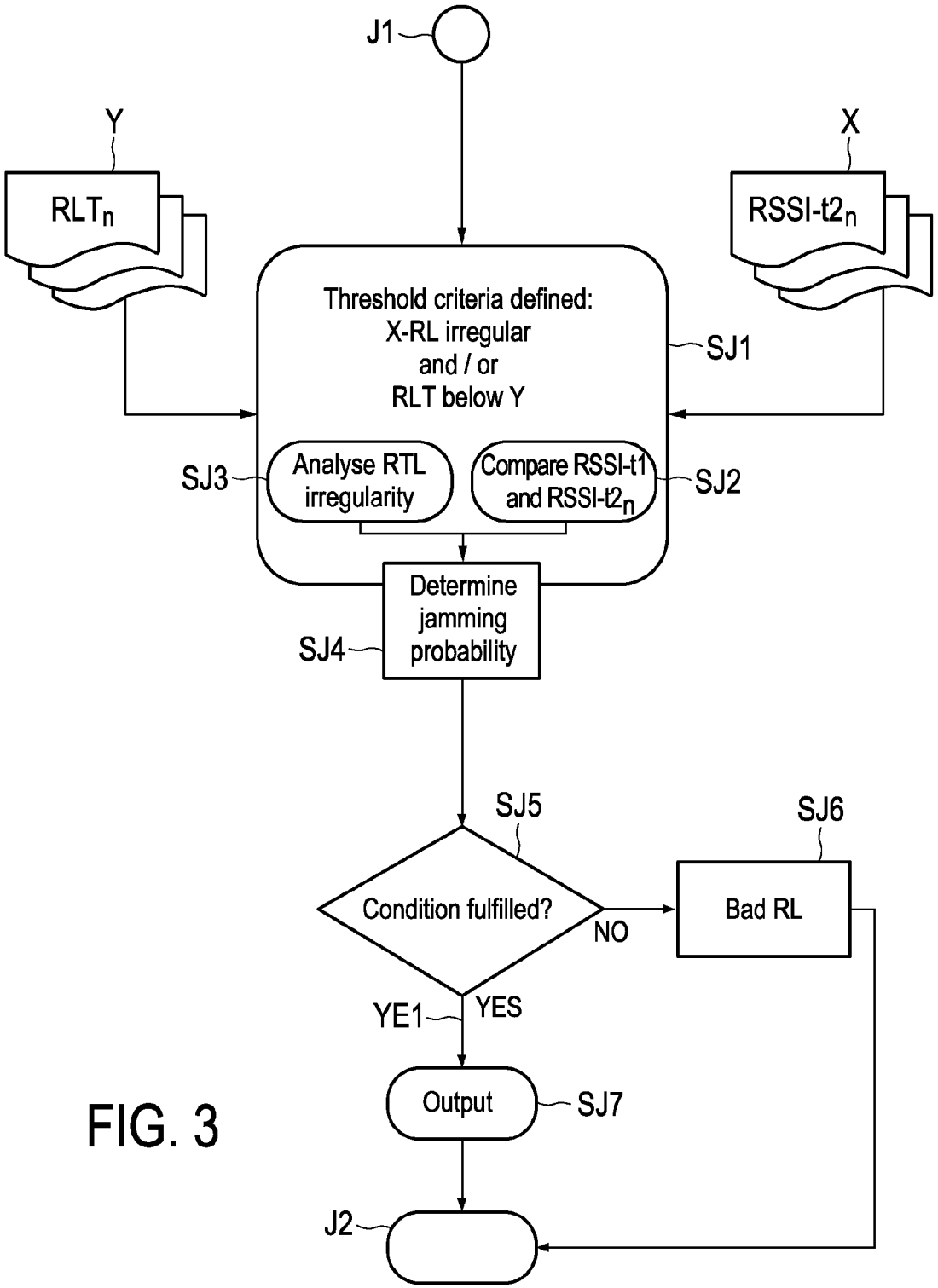
J1
Y
RLTn
X
RSSI-t2n
Threshold criteria defined:
X-RL irregular
and / or
RLT below Y
SJ1
SJ3
Analyse RTL irregularity
Compare RSSI-t1 and RSSI-t2n
SJ2
Determine jamming probability
SJ4
SJ5
SJ6
Condition fulfilled?
NO
Bad RL
YE1
YES
Output
SJ7
J2

FIG. 3

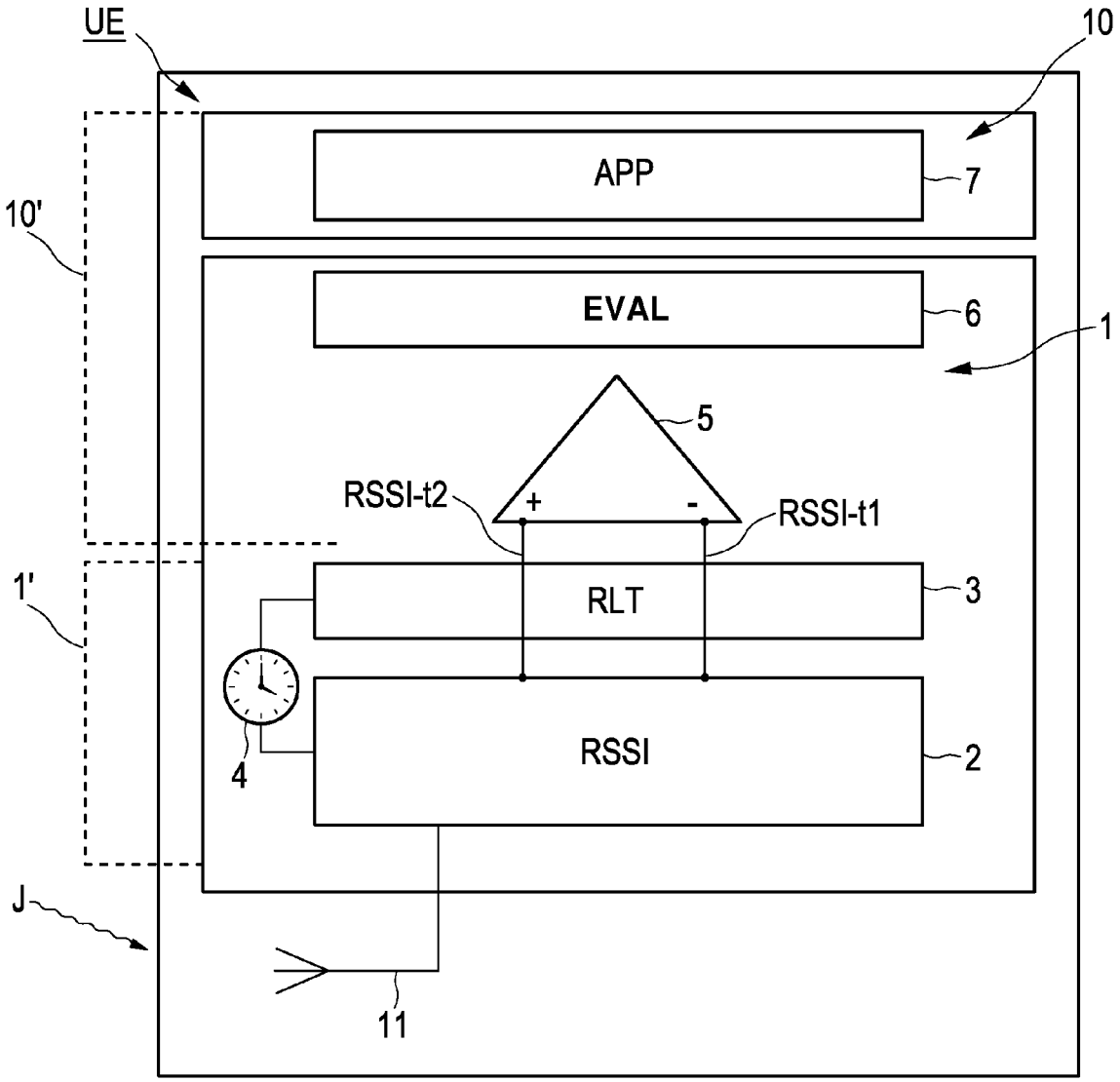

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 12 15 6957

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CA 2 433 242 A1 (NEWTRAX TECHNOLOGIES INC [CA]) 3 January 2004 (2004-01-03) * abstract * * page 3, line 16 - page 8, line 15 * * figures 1-2 * -----	1-18	INV. H04K3/00
X,D	WO 2007/019814 A1 (SIEMENS AG [DE]; LANDGRAF ROBERT [DE]) 22 February 2007 (2007-02-22) * abstract * * page 4, line 15 - page 7, line 5 * * page 7, line 21 - page 14, line 21 * * figures 1-2 * -----	1-18	
X,D	WO 2005/112321 A1 (DAI TELECOM S P A [IT]; MOSCOVITZ YOSSI [IL]; DEPERINI FABIO [IT]; LOC) 24 November 2005 (2005-11-24) * abstract * * page 2, line 4 - page 3, line 4 * * page 3, line 20 - page 15, line 18 * * figure 4 * -----	1-18	TECHNICAL FIELDS SEARCHED (IPC)
X	EP 1 363 421 A2 (BOOMERANG TRACKING INC [CA]) 19 November 2003 (2003-11-19) * abstract * * paragraph [0006] - paragraph [0020] * * figure 2 * -----	1-18	H04K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 August 2012	Dujardin, Corinne

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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