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(54) Title: SELECTING NETWORK CONNECTIVITY

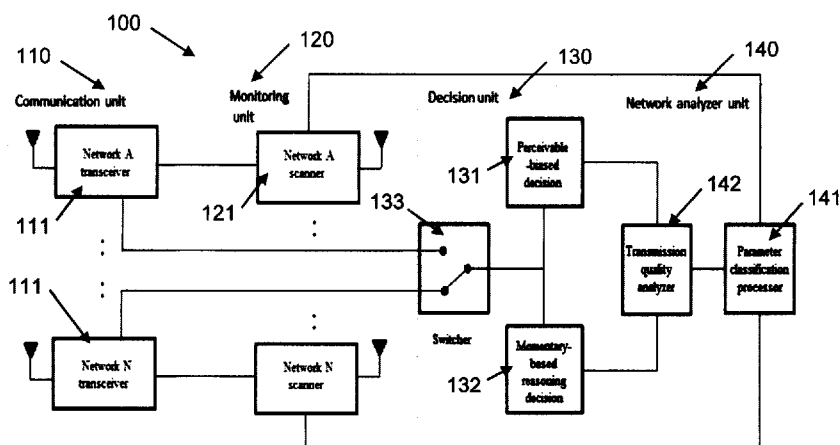


FIG. 1

(57) Abstract: The present invention relates to a system and method for selecting network connectivity. The system (100) is able to continuously scan multiple networks while staying connected to a first subscribed network. When the connection speed of the first subscribed network falls below a predetermined threshold, the system connects to a second subscribed network. The second subscribed network is selected based on perceivable biases and momentary-based reasoning. The system (100) comprises of a communication unit (110), a monitoring unit (120), a decision unit (130) and a network analyser unit (140).

SELECTING NETWORK CONNECTIVITY**FIELD OF INVENTION**

The present invention relates to a system and method for selecting network
5 connectivity.

BACKGROUND OF THE INVENTION

One of the requirements for future International Mobile Telecommunication
Advance technologies (IMT-Advance) is to dynamically share and use the network
10 resources to support smooth handovers across heterogeneous network that crosses
different technologies and spectrum bands such as General Packet Radio Services
(GPRS), Universal Mobile Telecommunications System (UMTS), Worldwide
Interoperability for Microwave Access (WiMAX), LTE, or WiFi. To choose best
network connectivity, conventional radio communication terminal sequentially scans
15 for available networks, dis-associates with the connected network and re-associates
with a selected network.

However, these activities can cause non-continuous network monitoring,
transmission interruption, individual network scanning delay, inaccurate data
20 monitoring and data loss. Non-continuous network monitoring happens because the
transmission and scanning activity shares the same time slot. Therefore, the
scanning activity has to be scheduled to accommodate transmission activity while
data is transmitted. When scanning activity is active, transmission activity has to be
on hold to make the time slot available. This causes transmission interruption for data
25 that is being transmitted, vulnerable and random data such as voice and video data
is affected. In addition to that, comprehensive individual network scanning activity is
delayed due to limited availability of the time slot since the time slot is shared. As a
result, the networks scanned may not reflect actual result as the scanning of the
network was not within the same time period, this causes inaccurate data monitoring
30 of the system. Data loss may also occur in instance where the system needs to
connect to another network due slow network connection and scanning activity is
scheduled to begin. Data integrity that is also being compromised due to
transmission activity is on hold.

Therefore, there is a need to provide a system for selecting network connectivity that addresses the above mentioned drawbacks.

SUMMARY OF INVENTION

5 In one aspect of the present invention, a system for selecting network connectivity (100) is provided. The system (100) comprises a communication unit (110), wherein the communication unit (110) includes at least two transceivers (111). Moreover, the system (100) is characterised in that it further includes a monitoring unit (120) for monitoring transmission quality variables which includes received signal
10 strength (RSSI) and connection speed, wherein the monitoring unit (120) includes at least two network scanners (121), and wherein each network scanner (121) is connected to a transceiver of the communication unit (111); a network analyser unit (140), wherein the network analyser unit (140) includes the parameter classification processor (141) and a transmission quality analyser (142), and wherein the
15 parameter classification processor (141) is configured to rank each network channel based on the transmission quality variables and the transmission quality analyser (142) is configured to evaluate each network based on the monitored transmission quality variables, and wherein the parameter classification processor (141) is connected to the at least two network scanners (121) and the transmission quality
20 analyser (142); and a decision unit (130), wherein the decision unit (130) includes a perceivable-based decision module (131), a momentary-based decision module (132), and a switch (133), wherein the perceivable-based decision module (131) is configured to determine stability percentage of each network based on the transmission quality variables change over a period of time and the momentary-
25 based decision module (132) is configured to determine momentary value of the transmission quality variables for each network, and wherein the perceivable-based decision module (131) and the momentary-based decision module (132) are connected to the transmission quality analyser (142) and the switch (133).

30 Preferably, each network scanner (121) is configured to monitor transmission quality variables from a lowest channel frequency to a highest channel frequency of a particular network.

35 In another aspect of the present invention, a method for selecting network connectivity using the system (100) is provided. The method is characterised by the

steps of connecting one of the transceivers (111) to a first subscribed network; monitoring transmission quality variables by each network scanner (121), wherein the transmission quality variables refer to received signal strength (RSSI) and connection speed of each channel frequency in each particular network; processing and analysing the transmission quality variables in the network maintenance table by the network analyser unit (140); selecting a second subscribed network for switching by the decision unit (130); and switching connection from the transceiver (111) for the first subscribed network to the transceiver (111) for the second subscribed network if the connection speed of the first subscribed network falls below a predetermined threshold.

Preferably, the step of monitoring network transmission quality variables includes receiving a list of subscribed networks; obtaining all channels in the subscribed networks; sorting the list based on the channel frequencies in an ascending order for each subscribed network; measuring transmission quality variables of each channel in each network; and storing the measured transmission quality variables in a network maintenance table.

Preferably, the step of processing and analysing the transmission quality variables includes plotting each channel for all networks to its corresponding time, and the transmission quality variables; calculating average rate of reaction for each time bin for each channel; aggregating the average rate of reaction to calculate an overall average rate for each network; classifying each network channel as a good, average or bad connection by comparing overall average rate for each channel to predefined thresholds; setting a variable priority is set for each channel based on the classification; ranking each network based on its variable priority and overall average value; plotting and classifying a transmission quality matrix based on the transmission quality variables; and storing the transmission quality matrix into a network performance table, wherein the network performance table includes a ranking of each channel of the subscribed networks.

Preferably, the step of selecting a second subscribed network includes extracting an average rate of reaction in specific time range for each network from a network performance table; calculating an error difference for each network, wherein the error difference is a difference between average rate of reaction and the overall

average; setting an error limit; comparing the error difference for each network with the error limit; calculating a stability percentage for each network; ranking each channel of each network according to its stability percentage in a descending order; determining whether connection speed of the first subscribed network is below a predetermined threshold; if the connection speed is below the predetermined threshold, obtaining momentary values of the transmission quality variables for each channel of all networks; storing each network with its corresponding momentary value and percentage stability in the network maintenance table; ranking the networks are ranked from most significant to least significant based on the momentary value and percentage stability; and suggesting the network with the highest ranking order as the second subscribed network for switching.

Preferably, the system (100) maintains connection with the first subscribed network if the current network speed is above the predetermined threshold.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. 1 shows a functional block diagram of a system for selecting network connectivity (100) according to an embodiment of the present invention.

FIG. 2 shows a flowchart of a method for selecting network connectivity according to an embodiment of the present invention.

FIG. 3 is a flowchart of a network monitoring sub process according to an embodiment of the present invention.

FIG. 4 is a flowchart of a network analysis sub process according to an embodiment of the present invention.

FIG. 5 is a flowchart of a network communication selection sub process according to an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well known functions or constructions are not described in detail since they would obscure the description with unnecessary detail.

Referring to **FIG. 1**, there is shown a functional block diagram of a system for selecting network connectivity (**100**) according to an embodiment of the present invention. The system (**100**) is able to continuously scan multiple networks while staying connected to a network. Such network may include, but not limited to General Packet Radio Services (GPRS), Universal Mobile Telecommunications System (UMTS), Worldwide Interoperability for Microwave Access (WiMAX), LTE, or WiFi. The system (**100**) comprises of a communication unit (**110**), a monitoring unit (**120**), a decision unit (**130**) and a network analyser unit (**140**).

The communication unit (**110**) is used for transmitting and receiving traffic via the network that the system (**100**) is connected to. The communication unit (**110**) further includes at least two transceivers (**111**), wherein each transceiver (**111**) is connected to an antenna and dedicated to a particular frequency band for connecting to a particular network such as, but not limited to frequency band of 2.1 GHz for connecting to 3G network, frequency band of 1800 MHz for connecting to GSM network, frequency band of 2.6 GHz for connecting to LTE network, and frequency band of 2.4 GHz for connecting to WiFi network. Each transceiver (**111**) is connected to a respective network scanner (**121**) of the monitoring unit (**120**) and a switcher (**133**) of the decision unit (**130**).

The monitoring unit (**120**) is used for monitoring network connectivity within its coverage. The monitoring unit (**120**) comprises of at least two network scanners (**121**), wherein each network scanner (**121**) is configured to monitor received signal strength (RSSI) and connection speed from a lowest channel frequency to a highest channel frequency of a particular network, wherein the RSSI and connection speed is referred to as transmission quality variables herein below. Moreover, each network scanner (**121**) is connected to the respective transceiver of the communication unit (**111**), and a parameter classification processor (**141**) of the network analyser unit (**140**).

The network analyser unit (140) includes the parameter classification processor (141) and a transmission quality analyser (142). The parameter classification processor (141) is configured to rank each network channel based on the transmission quality variables for easy examining the network quality. The network quality refers to the quality of the network speed. The transmission quality analyser (142) is configured to evaluate each network based on the monitored transmission quality variables. In particular, the parameter quality analyser (142) classifies a network channel as a good, average or bad connection based on predefined thresholds. The transmission quality analyser (142) is connected to the parameter classification processor (141), a perceivable-based decision module (131) and a momentary-based decision module (132) of the decision unit (130).

The decision unit (130) includes the perceivable-based decision module (131), the momentary-based decision module (132), and a switch (133). The perceivable-based decision module (131) is configured to determine stability percentage of each network based on the transmission quality variables change over a period of time, whereas the momentary-based decision module (132) is configured to determine momentary value of the transmission quality variables for each network. Based on the stability percentage and the momentary value, the networks are ranked and the network with highest rank order is selected for connection. Both perceivable-based decision module (131) and network and momentary-based decision module (132) are further connected to the switch (133) which switches connectivity between networks based on the decision of the perceivable-based decision module (131) and the momentary-based decision module (132).

Referring now to FIG. 2, there is shown a flowchart of a method for selecting network connectivity according to an embodiment of the present invention. Initially, as in step 400, one of the transceivers (111) connects to a first subscribed network. Thereon, each network scanner (121) monitors transmission quality variables of its respective network by performing a monitoring sub process as in step 500. The transmission quality variables refer to received signal strength (RSSI) and connection speed of each channel frequency in a particular network. The transmission quality variables obtained by the network scanners (121) are temporarily stored in a network maintenance table, wherein the network maintenance table includes all channels for

each subscribed network and its corresponding measured RSSI and connection speed. In step 600, the network analyser unit (140) processes and analyses the transmission quality variables in the network maintenance table by performing a network analysis sub process. As a result, the network analysis sub process provides
5 a network performance table that includes a ranking of the subscribed networks based on the measured RSSI and connection speed. Based on the network performance table, the decision unit (130) selects a second subscribed network for switching by performing a selection sub process as in step 700. The selection sub process uses perceivable biases and momentary-based reasoning to select a
10 preferable network as a second subscribed network. In step 800, the switch (133) switches the connection from the transceiver for the first subscribed network to the transceiver for the second subscribed network when the connection speed of the first subscribed network falls below a predetermined threshold.

15 Referring to FIG. 3, there is shown a flowchart of the monitoring sub process which is performed by the network scanner (121) as depicted in step 500 of the method of FIG. 2. Initially, as in step 510 and 511, the network scanners (121) receive a list of subscribed networks and thereon, each network scanner (121) obtains all channels in its respective network. In step 512, the list is sorted based on
20 the channel frequencies in an ascending order for each subscribed network. Thereon, the network scanners (121) measure transmission quality variables which include received signal strength (RSSI), connection speed and corresponding time of all networks as in step 513. The measured transmission quality variables are then stored in a network maintenance table by the monitoring unit (120) as in step 514,
25 wherein the network maintenance table includes all channels for each subscribed network and its corresponding measured RSSI and connection speed. The measurement of the transmission quality variables is repeated for each channel as in decision 515 and step 516. If the transmission quality variables for all channels have been measured, the method returns to step 513 in order to periodically repeat
30 scanning and measuring the variables.

FIG. 4 shows a flowchart of the network analysis sub process which is performed by the network analyser unit (140) as depicted in step 600 of the method of FIG. 2. In step 610, the network maintenance table is transmitted from the
35 monitoring unit (120) to the network analyser unit (140). Then, the transmission

quality analyser (142) plots each channel for all networks to its corresponding time, and the transmission quality variables as in step 611. In step 612, the transmission quality analyser (142) calculates and stores the average rate of reaction for each time bin for each channel. The average rate of reaction refers to an average RSSI and connection speed over a period of time. For example, if the monitoring unit (120) monitors each network for approximately 30mins and measures the transmission quality variables for every 10mins, the transmission quality analyser (142) accumulates all the transmission quality variables and averages the accumulated transmission quality variables over the period of 30mins. In step 613, the average rate of reaction is aggregated to calculate an overall average rate for each network by the transmission quality analyser (142). Then, the overall average rate corresponding to the network is stored in the network analyser unit (140) as in step 614. The transmission quality analyser (142) classifies a network channel as a good, average or bad connection by comparing overall average rate for each channel to predefined thresholds. Based on this classification, a variable priority is set for each channel from most to least important by the transmission quality analyser (142) as in step 615, wherein the channel with a good connection is classified as most important, and the channel with a bad connection is classified as least important.

The networks are then ranked according to its priority variable and overall average value by the parameter classification processor (141) as in step 616. In step 617, the parameter classification processor (141) plots and classifies a transmission quality matrix based on the transmission quality variables. The classification is done by comparing an average connection speed within a particular time frame to predefined thresholds, and thereon, classifying whether the connection within a particular time frame as good, average or bad connection.

The transmission quality matrix is then stored into the network performance table as in step 618, wherein the network performance table includes a ranking of each channel of the subscribed networks.

Referring now to FIG. 5, there is shown a flowchart of the selection sub process which is performed by the decision unit (130) as depicted in step 700 of the method of FIG. 2. In step 710, the network performance table is transmitted from the network analyser unit (140) to the decision making unit (130). Then, the average rate

of reaction in specific time range of each network is extracted from the table in step 711. The difference between average rate of reaction and the overall average for each network is calculated in step 712. The difference is referred to as the error difference, wherein the overall average is defined as a reference value for the average rate of reaction.

An error limit is then set to a predefined value and the error difference for each network is compared with the error limit as in step 713. If the error difference exceeds the error limit, the network is deemed as an instable and unreliable network. Otherwise, the network is deemed as a stable network. In step 714, a stability percentage is calculated by the perceivable-based decision module (131) based on an equation below:

$$\text{Stability percentage} = (\text{Error difference} / \text{Reference value}) * 100;$$

where the error difference is a difference between average rate of reaction and overall rate, and reference value refers to the overall rate. The perceivable-based decision module (131) then ranks each channel of each network according to its stability percentage in a descending order as in step 715.

Thereon, as in decision 716, the perceivable-based decision module (131) determines whether connection speed of the first subscribed network is below the predetermined threshold. If the connection speed is below the predetermined threshold, the momentary-based decision module (132) obtains momentary values of the transmission quality variables for each channel of all networks as in step 717. Each network with its corresponding momentary value and percentage stability is stored by the momentary-based decision module (132) in the network maintenance table as in step 718. Then, the networks are ranked from most significant to least significant based on the momentary value and percentage stability as in step 719, wherein the network with the highest momentary value and lowest stability percentage is ranked as the most significant while the network with lowest momentary value and highest stability percentage is ranked as the least significant. The transmission quality analyser (142) via the perceivable-based decision module (131) and the momentary-based decision module (132) suggests the network with the highest ranking order to the switcher (133) as in step 720. The switcher switches

connection from the transceiver of the first subscribed network to the transceiver of the suggested network.

However, if the current network speed is above the predetermined threshold,
5 the connection is maintained with the first subscribed network as in step **721**.

While embodiments of the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the invention. Rather, the words used in the specifications are words of description rather
10 than limitation and various changes may be made without departing from the scope of the invention.

CLAIMS

1. A system for selecting network connectivity (100) comprising:
a communication unit (110), wherein the communication unit (110)
includes at least two transceivers (111),

5

wherein the system (100) is characterised in that it further includes:

a monitoring unit (120) for monitoring transmission quality variables
which includes received signal strength (RSSI) and connection speed,
wherein the monitoring unit (120) includes at least two network scanners
10 (121), and wherein each network scanner (121) is connected to a transceiver
of the communication unit (111);

a network analyser unit (140), wherein the network analyser unit (140)
includes the parameter classification processor (141) and a transmission
quality analyser (142), and wherein the parameter classification processor
15 (141) is configured to rank each network channel based on the transmission
quality variables and the transmission quality analyser (142) is configured to
evaluate each network based on the monitored transmission quality variables,
and wherein the parameter classification processor (141) is connected to the
20 at least two network scanners (121) and the transmission quality analyser
(142); and

a decision unit (130), wherein the decision unit (130) includes a
perceivable-based decision module (131), a momentary-based decision
25 module (132), and a switch (133), wherein the perceivable-based decision
module (131) is configured to determine stability percentage of each network
based on the transmission quality variables change over a period of time and
the momentary-based decision module (132) is configured to determine
momentary value of the transmission quality variables for each network, and
30 wherein the perceivable-based decision module (131) and the momentary-
based decision module (132) are connected to the transmission quality
analyser (142) and the switch (133).

2. The system (100) as claimed in claim 1, wherein each network scanner (121) is configured to monitor transmission quality variables from a lowest channel frequency to a highest channel frequency of a particular network.
- 5 3. A method for selecting network connectivity using the system (100) as claimed in claim 1 is characterised by the steps of:
- a) connecting one of the transceivers (111) to a first subscribed network;
 - b) monitoring transmission quality variables by each network scanner (121), wherein the transmission quality variables refer to received
10 signal strength (RSSI) and connection speed of each channel frequency in each particular network ;
 - c) processing and analysing the transmission quality variables in the network maintenance table by the network analyser unit (140);
 - d) selecting a second subscribed network for switching by the decision
15 unit (130); and
 - e) switching connection from the transceiver (111) for the first subscribed network to the transceiver (111) for the second subscribed network if the connection speed of the first subscribed network falls below a predetermined threshold.
- 20 4. The method as claimed in claim 3, wherein the step of monitoring network transmission quality variables includes the step of:
- a) receiving a list of subscribed networks;
 - b) obtaining all channels in the subscribed networks;
 - 25 c) sorting the list based on the channel frequencies in an ascending order for each subscribed network;
 - d) measuring transmission quality variables of each channel in each network; and
 - e) storing the measured transmission quality variables in a network
30 maintenance table.
5. The method as claimed in claim 3, wherein the step of processing and analysing the transmission quality variables includes the step of:
- a) plotting each channel for all networks to its corresponding time, and
35 the transmission quality variables;

- 5 b) calculating average rate of reaction for each time bin for each channel;
 c) aggregating the average rate of reaction to calculate an overall average rate for each network;
 d) classifying each network channel as a good, average or bad connection by comparing overall average rate for each channel to predefined thresholds;
 e) setting a variable priority is set for each channel based on the classification;
10 f) ranking each network based on its variable priority and overall average value;
 g) plotting and classifying a transmission quality matrix based on the transmission quality variables; and
 h) storing the transmission quality matrix into a network performance table, wherein the network performance table includes a ranking of each channel of the subscribed networks.
- 15
6. The method as claimed in claim 3, wherein the step of selecting a second subscribed network includes the step of:
- 20 a) extracting an average rate of reaction in specific time range for each network from a network performance table;
 b) calculating an error difference for each network, wherein the error difference is a difference between average rate of reaction and the overall average;
 c) setting an error limit;
25 d) comparing the error difference for each network with the error limit;
 e) calculating a stability percentage for each network;
 f) ranking each channel of each network according to its stability percentage in a descending order;
 g) determining whether connection speed of the first subscribed network is below a predetermined threshold;
30 h) if the connection speed is below the predetermined threshold, obtaining momentary values of the transmission quality variables for each channel of all networks;
 i) storing each network with its corresponding momentary value and percentage stability in the network maintenance table;
- 35

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j) ranking the networks are ranked from most significant to least significant based on the momentary value and percentage stability; and

5

k) suggesting the network with the highest ranking order as the second subscribed network for switching.

7. The method as claimed in claim 3, wherein maintaining connection with the first subscribed network if the current network speed is above the predetermined threshold.

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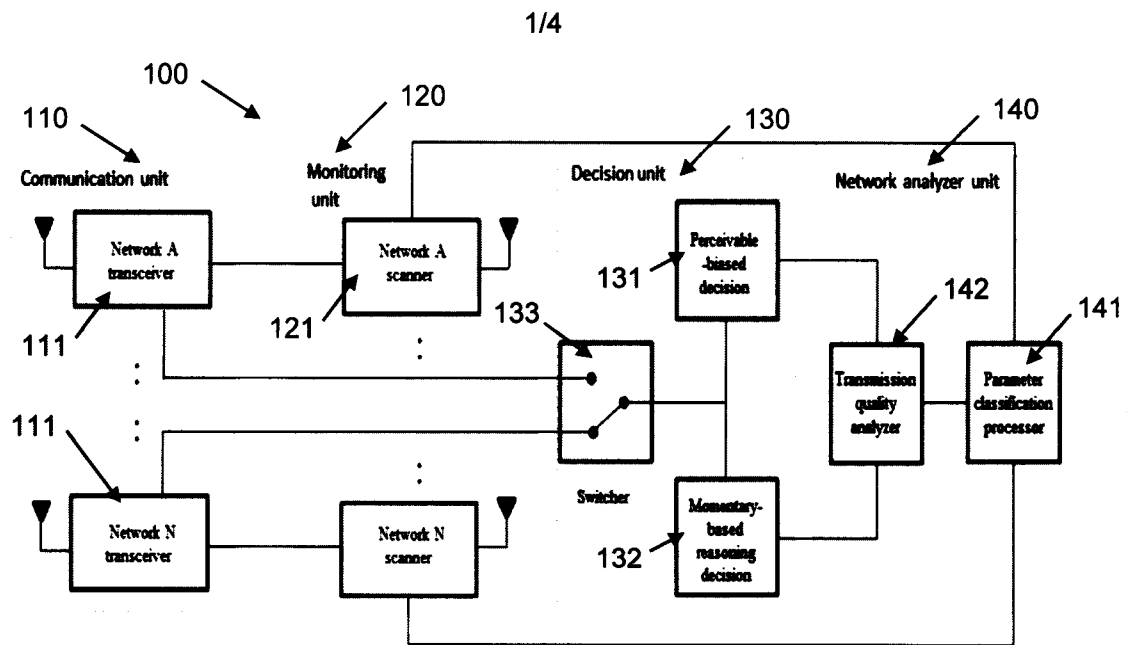


FIG. 1

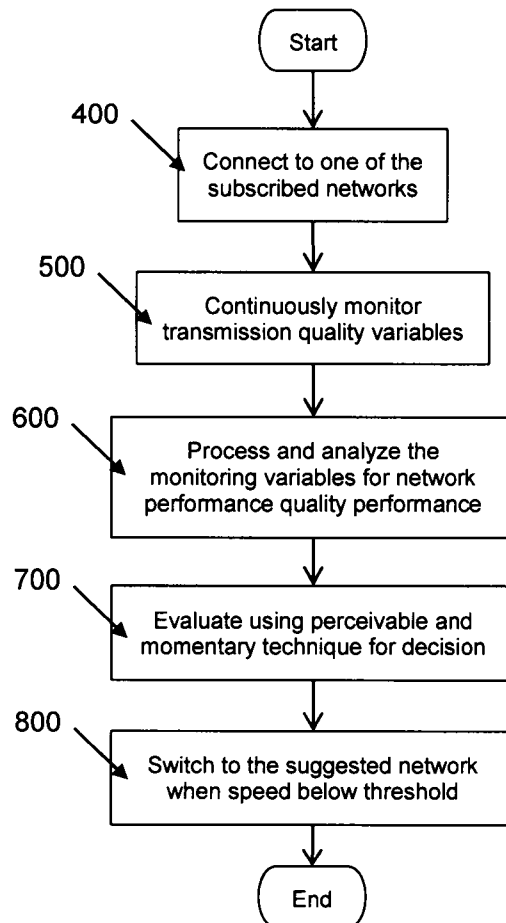


FIG. 2

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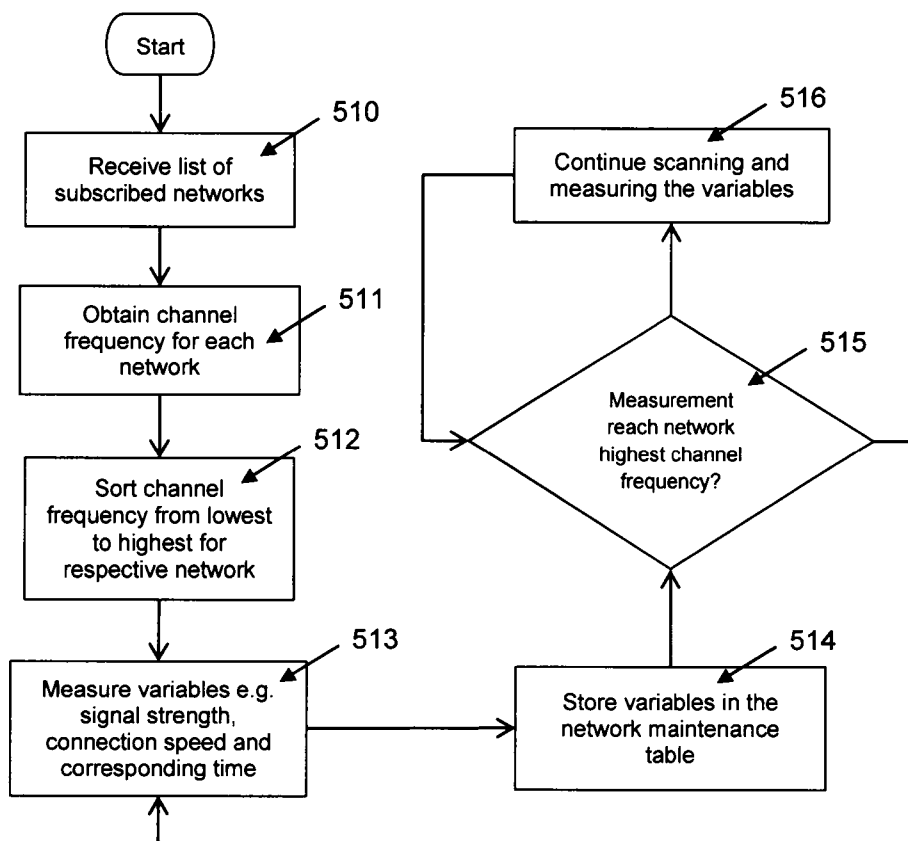


FIG. 3

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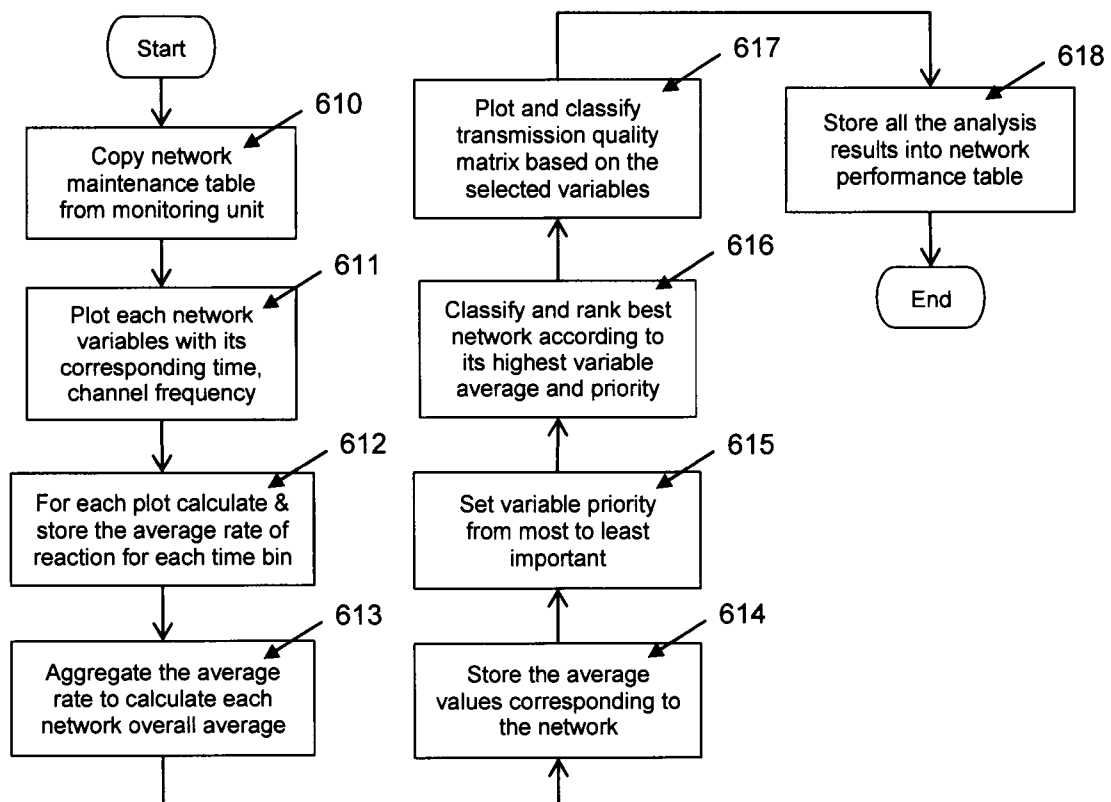


FIG. 4

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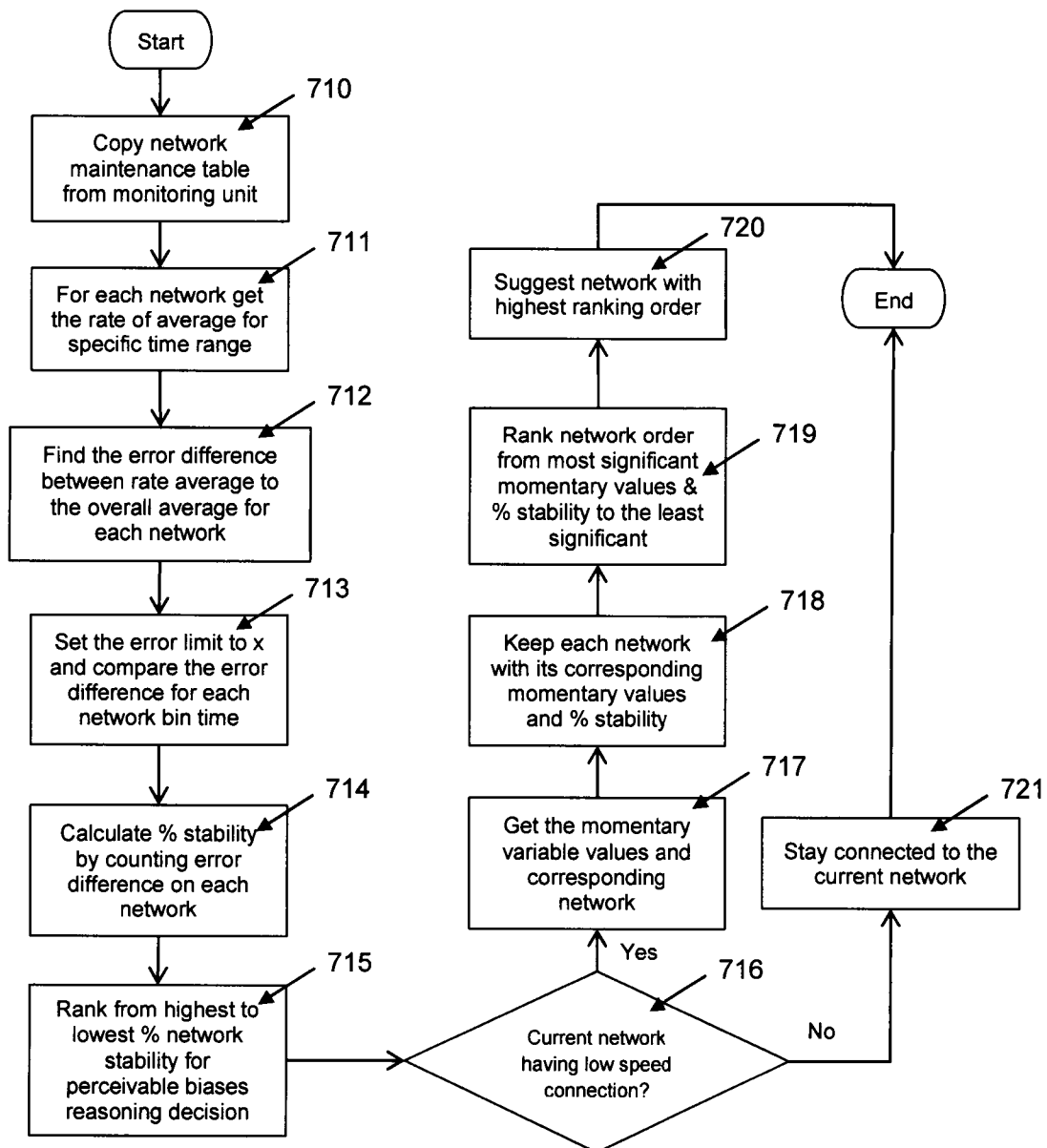


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2014/000176

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W36/32
ADD. H04W36/14 H04W36/30 H04W36/00

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)
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, COMPENDEX, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/278141 A1 (CHOI-GROGAN YUNG SHIRLEY [US] ET AL) 4 November 2010 (2010-11-04) paragraph [0005] - paragraph [0011] paragraph [0057] - paragraph [0076]; figures 5,6 paragraph [0089] - paragraph [0091]; figure 10	1-7
Y	EP 1 635 592 A1 (CIT ALCATEL [FR] ALCATEL LUCENT [FR]) 15 March 2006 (2006-03-15) paragraph [0049] - paragraph [0050]; figure 3	1-7



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

27 November 2014

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04/12/2014

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2014/000176

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2009/057960 A2 (LG ELECTRONICS INC [KR]; YI SEUNG JUNE [KR]; LEE YOUNG DAE [KR]; CHUN) 7 May 2009 (2009-05-07) page 8, line 3 - page 12, line 5 page 28, line 1 - page 35, line 13 -----	1-7
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