Title: APPARATUS FOR TESTING MULTIPLE NETWORKS

Abstract: There is provided an apparatus for testing multiple mobile communication networks, comprising an antenna; first and second testing units, each unit comprising radio transceiver circuitry for communicating with a respective one of the multiple mobile communication networks; means for retaining a network authentication device for the respective network; control circuitry for (i) maintaining a call over the respective network using the antenna and the respective radio transceiver circuitry; and (ii) measuring the performance of the respective network during the call; wherein the apparatus comprises means for controlling the first and second test units to maintain a call over their respective networks and to measure the performance of their respective networks at substantially the same time.
before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
APPARATUS FOR TESTING MULTIPLE NETWORKS

Technical Field of the Invention

The invention relates to an apparatus for testing multiple mobile communication networks, and in particular relates to an apparatus and method for concurrently testing multiple mobile communication networks at a particular location.

Background to the Invention

Currently, there are many different types of wireless communication network available. Each of these networks, including, but not limited to, cellular mobile networks such as GSM, GPRS, EDGE or 3G, has different advantages and disadvantages, and different performance depending on the architecture of the network, such as the positioning of base station antennas, the surrounding landscape and present level of network traffic.

In many countries, there are several different networks overlaying a single area, offering the consumer a choice of network. Often, there are several networks, each of the same type, but operated by different service providers.

As each of the service providers have their own network architecture (base stations, etc.), there can often be different levels of performance between networks of the same type.

It is clear that, for a particular network to be attractive to consumers, the service provider must provide a network that is comparable or better than the networks of its competitors.

However, there is no easy way of comparing the performance of two or more mobile communication networks.

US 2002/0155831 describes a system for comparing data quality for multiple wireless communication networks. The system requires first and second wireless devices to establish data calls with respective first and second wireless communication networks, and to obtain information regarding the quality of the data service provided by the respective wireless communication networks.

However, this system does not allow strictly comparable measurements to be made. In particular, the first and second devices may make different measurements of the same signal, since every mobile terminal antenna receives signals differently, and there can be slight variations in the transceiver circuitry of the terminals.
Often, this variation in measurements from one device to another is small enough so that it is not discernible to the consumer, but it can provide misleading results to a service provider comparing the performance of their network to those of their competitors.

Therefore, there is a need for a device for testing multiple mobile communication networks that can test and measure the networks automatically, and that can overcome the disadvantages suffered by the prior art test systems, such as variations in signal measurements caused by different antennas and transceiver circuitry. Furthermore, it is also desirable to minimise the costs associated with such a device.

Summary of the Invention

There is therefore provided an apparatus for testing multiple mobile communication networks, comprising: an antenna; first and second testing units, each unit comprising: radio transceiver circuitry for communicating with a respective one of the multiple mobile communication networks; means for retaining a network authentication device for the respective network; control circuitry for (i) maintaining a call over the respective network using the antenna and the respective radio transceiver circuitry; and (ii) measuring the performance of the respective network during the call; wherein the apparatus comprises means for controlling the first and second test units to maintain a call over their respective networks and to measure the performance of their respective networks at substantially the same time.

Brief Description of the Drawings

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the following drawings, in which:

Figure 1 shows a test apparatus and communications system according to the present invention; and

Figure 2 shows part of the test apparatus according to the present invention.

Detailed Description of the Preferred Embodiments

Figure 1 shows a test apparatus 2 and a group of mobile communications networks 4.
Each of the networks in the group 4 is of a particular type (for example: GSM, GPRS, EDGE, 3G) and is operated by a respective service provider.

Preferably, the test apparatus 2 comprises an antenna 6 for transmitting and receiving signals over the different networks 4a and 4b in the group 4, and the antenna 6 is connected to two test units 8, 10 in the test apparatus 2.

For ease of illustration, Figure 1 shows an apparatus 2 including only two test units. It will be appreciated that the test apparatus 2 may comprise more than two test units, the exact number depending on the number of networks to be monitored concurrently. Each of the additional test units will be connected to the same antenna 6.

Although the invention will be described below with reference to two or more distinct "test units", it will be appreciated that the apparatus may comprise a single unit that performs the same functions as multiple test units.

According to a preferred embodiment, the test units 8, 10 are connected together via a communications bus 12, which allows the test units 8, 10 to be calibrated relative to each other. Test unit calibration will be described further below.

Each of the test units 8, 10 also comprises a network authentication device 14, 16 for a respective one of the networks in the group of networks 4.

In Figure 1, the first test unit 8 has a network authentication device for network A, 4a, and the second test unit 10 has a network authentication device for network B, 4b.

Preferably, the network authentication devices 14, 16 are Subscriber Identity Module (SIM) cards.

In accordance with the present invention, the test apparatus 2 makes measurements of multiple mobile communication networks. Specifically, to provide measurements that allow ready comparison of the networks being tested, the test units 8, 10 in the test apparatus 2 are controlled so that they each maintain a call over their respective network 4a, 4b using the apparatus antenna 6 at substantially the same time.

It will be appreciated by a person skilled in the art that the time required to establish a call (whether incoming or outgoing) depends on various factors (such as the type of network, current network traffic, etc.) and it may not be possible to establish calls in multiple test units 8, 10 at exactly the same time.

As used herein, "maintain a call" means to allow a call between the test unit and respective network to continue. "Calls" includes voice calls, data calls, text messages sent using the Short Message Service (SMS), messages sent using the Multimedia Messaging Service (MMS) or any other type of communications traffic provided by the
networks in the group 4. The calls may be initiated by a test unit 8, 10 or be received over the respective network 4a, 4b of a test unit 8, 10.

Once each of the test units 8, 10 is maintaining a call, the test units 8, 10 are controlled to take measurements relating to the performance of their respective network.

Again, to allow the performance of the networks to be readily compared, the measurements taken by the test units 8, 10 are taken at substantially the same time.

The test units 8, 10, may take various measurements relating to the performance of the networks 4a, 4b. For example, each test unit 8, 10 may measure the strength of a signal received over their respective networks during the call. Alternatively, or in addition to, each test unit 8, 10 may measure a signal-to-noise ratio for a signal received over their respective networks during the call, the strength of signals received in neighbouring cells of their respective networks 4, information relating to the cell serving the respective test unit 8, 10, the rate of data throughput, the bit error rate in received data, the quality of a voice sample received or the number of calls dropped. It will be appreciated that many other measurements may be taken by each test unit 8, 10 to analyse the performance of their respective network 4.

Preferably, the test units 8, 10 each perform the same measurements on their respective networks 4a, 4b at substantially the same time.

In further embodiments of the invention, the test units 8, 10 may also be controlled to take measurements relating to the performance of their respective networks 4a, 4b when the units are in an idle mode. The test units 8, 10 are in an idle mode when they are not maintaining a call over their respective network 4a, 4b.

The test units 8, 10 may measure the performance of a respective network 4a, 4b by measuring the strength of a signal received on a control channel. Alternatively, or in addition to, the test units 8, 10 may measure a signal-to-noise ratio of a signal received on a control channel or may measure signal strengths of signals received from neighbouring cells of their respective networks 4.

Preferably, the test apparatus 2 further comprises a system for measuring the position of the test apparatus 2.

In one embodiment, the position measurement system is a Global Positioning System (GPS) position measurement system.

The GPS receiver may be incorporated into the test apparatus 2, or each test unit 8, 10 may have a respective GPS receiver.

In a preferred embodiment of the present invention, to allow the test apparatus 2 to be used in different situations (i.e. to measure a varying number of networks
concurrently), the test units 8, 10 may be detachable from the test apparatus 2. Therefore, the appropriate number of test units 8, 10 can be connected to the test apparatus 2 to test the required number of mobile communication networks.

Preferably, to maximise the usage of the test units 8, 10, the test units 8, 10 are each provided with a means for retaining a network authentication device, rather than having an integral authentication device. This allows the same test unit to be used to measure networks operated by different service providers.

In one embodiment of the invention, the test units 8, 10 each have their own antenna so that they can also be used independently of the test apparatus 2 and of each other. This allows the test units 8, 10 to test their respective network 4 individually.

In accordance with this embodiment of the invention, when the test units 8, 10 are in use within a test apparatus 2, the test units 8, 10 disable their respective antennas and use the common test apparatus antenna 6.

Alternatively, the test apparatus 2 may not be provided with an antenna 6, and one of the antennas in the test units 8, 10 is used as the common antenna. The antenna in the other test unit is disabled whilst the test units are connected to each other.

As described above, the test apparatus 2 may have a communications bus 12 connecting the test units 8, 10 together, to allow the test units 8, 10 to be calibrated relative to each other.

For example, it is difficult to derive a meaningful comparison of two or more networks if the respective test units 8, 10 measure the same signal differently.

Test unit calibration is particularly necessary when the antenna of one test unit 8, 10 is used by the other test units in the test apparatus 2.

To calibrate the test units 8, 10 relative to each other, both test units 8, 10 take a measurement of a signal received through the antenna 6. The signal may not be a specific signal intended for the test units 8, 10, but may just be the signal received over the air interface at that time.

Once the test units 8, 10 have each measured the signal, the measurements are compared. In an ideal system, the measurements taken by the test units 8, 10 will be the same. However, in a real system, there will be differences between the measurements caused by slight differences in the electrical properties of the circuitry in the test units.
The difference between the measurements is stored and is taken into consideration when evaluating measurements taken of the performance of the networks by the test units 8, 10.

Alternatively, or in addition to this, the test units 8, 10 may alternate the network in the group 4 that they measure. By varying the network that each test unit monitors over time, the differences in measurements resulting from the different electrical properties of the components in the test units 8, 10 will be averaged out.

In this case, each test unit 8, 10 will be adapted to communicate with at least one of the other networks in the group, and will have access to a network authentication device for that or those networks.

Once various measurements of some or all of the networks in the group 4 have been made by the test units 8, 10, the measurements are transmitted to a central server 18 via one or more of the networks in the group 4 and the internet 20.

The server 18 may comprise a module 22 for carrying out tasks related to the testing of the multiple networks according to the present invention. For example, module 22 may comprise a terminal management component 24 for controlling when the test apparatus 2 is to perform testing of the multiple networks.

Preferably, the measurements are transmitted to the server 18 from the test units 8, 10 using a wireless data network, such as a GPRS network.

Alternatively, the measurements may be transmitted to the server 18 using the Short Message Service (SMS) if a wireless data network is unavailable.

Figure 2 shows a test unit of the present invention in more detail.

The test unit 8 comprises a network authentication device 14, or a means for retaining a network authentication device, as described above.

The test unit 8 is connected to the antenna 6 via a connection point 26. In the preferred embodiments where the test unit 8 is detachable from the test apparatus 2, the test unit 8 is detachable from the antenna 6.

The test unit 8 comprises radio transceiver circuitry 28 connected to the antenna 6 via connection point 26. The transceiver circuitry 28 is connected to control circuitry 30, which controls the operation of the test unit 8 as described above.

The control circuitry 30 is connected to the network authentication device 14 and a memory 32, which stores the measurements made by the test unit 8 (including the position measurements when the test unit 8 includes a position measurement system), ready for the measurements to be retrieved and sent to the server 18.
When the test unit 8 comprises a position measurement system, such as GPS, the position measurement system receiver may be included in the radio transceiver circuitry 28.

There is therefore provided a test apparatus for concurrently collecting performance measurements on a number of mobile communication networks.
Claims

1. An apparatus for testing multiple mobile communication networks, comprising:
   an antenna;
   first and second testing units, each unit comprising:
   radio transceiver circuitry for communicating with a respective one of the
   multiple mobile communication networks;
   means for retaining a network authentication device for the respective
   network;
   control circuitry for (i) maintaining a call over the respective network using
   the antenna and the respective radio transceiver circuitry; and (ii) measuring the
   performance of the respective network during the call;
wherein the apparatus comprises means for controlling the first and second test units
   to maintain a call over their respective networks and to measure the performance of
   their respective networks at substantially the same time.

2. An apparatus as claimed in claim 1, wherein the means for retaining a network
   authentication device is a means for retaining a Subscriber Identity Module.

3. An apparatus as claimed in claim 1 or 2, wherein the apparatus further comprises a
   position measurement system for determining the location of the apparatus.

4. An apparatus as claimed in claim 1 or 2, wherein the test units each further
   comprise a position measurement system for determining the location of the test unit.

5. An apparatus as claimed in claim 3 or 4, wherein the position measurement system
   is a Global Positioning System position measurement system.

6. An apparatus as claimed in any preceding claim, wherein the control circuitry for
   maintaining a call in each of the test units is adapted to initiate outgoing calls and
   receive incoming calls.

7. An apparatus as claimed in any preceding claim, wherein the control circuitry for
   measuring the performance of the network during a call in each of the test units is
   further adapted to measure the performance of the respective network when the test
   unit is in an idle mode.
8. An apparatus as claimed in claim 7, wherein the control circuitry for measuring the performance of the network when the test unit is in an idle mode is adapted to measure a signal-to-noise ratio for a received signal on a control channel.

9. An apparatus as claimed in claim 7, wherein the control circuitry for measuring the performance of the network when the test unit is in an idle mode is adapted to measure the strength of a signal received on a control channel.

10. An apparatus as claimed in any preceding claim, wherein the control circuitry for measuring the performance of the network is adapted to measure the strength of the signal received during a call.

11. An apparatus as claimed in one of claims 1 to 9, wherein the control circuitry for measuring the performance of the network is adapted to measure a signal-to-noise ratio for a received signal during a call.

12. An apparatus as claimed in one of claims 1 to 9, wherein the control circuitry for measuring the performance of the network is adapted to measure a rate of data throughput for data received during a call.

13. An apparatus as claimed in one of claims 1 to 9, wherein the control circuitry for measuring the performance of the network is adapted to measure the bit error rate in data received during a call.

14. An apparatus as claimed in one of claims 1 to 9, wherein the control circuitry for measuring the performance of the network is adapted to measure the quality of a voice sample received during a call.

15. An apparatus as claimed in any preceding claim, wherein the means for controlling the first and second test units is further adapted to control the first and second test units to perform the same measurements on their respective networks at substantially the same time.
16. An apparatus as claimed in any preceding claim, wherein each test unit further comprises a memory for storing its respective performance and position measurements.

17. An apparatus as claimed in claim 16, wherein the control circuitry in each test unit is further adapted to retrieve the stored measurements from the memory and transmit them to a server over the respective mobile communication network.

18. An apparatus as claimed in claim 17, wherein the control circuitry is adapted to transmit the measurements to the server using a wireless data network.

19. An apparatus as claimed in claim 18, wherein the wireless data network is a GPRS network.

20. An apparatus as claimed in claim 17, wherein the control circuitry is adapted to transmit the measurements to the server using SMS messages.

21. An apparatus as claimed in any preceding claim, wherein the apparatus further comprises means for calibrating the measurements of the first and second test units.

22. An apparatus as claimed in claim 21, wherein the means for calibrating the measurements is adapted to compare a measurement of a signal or datum by the first test unit to a measurement of said signal by the second test unit.

23. An apparatus as claimed in any preceding claim, wherein at least one of the mobile communication networks is a GSM network.

24. An apparatus as claimed in any preceding claim, wherein at least one of the mobile communication networks is a GPRS network.

25. An apparatus as claimed in any preceding claim, wherein at least one of the mobile communication networks is an EDGE network.

26. An apparatus as claimed in any preceding claim, wherein at least one of the mobile communication networks is a third generation network.
27. An apparatus as claimed in any preceding claim, wherein the multiple mobile communication networks are operated by different service providers.

28. An apparatus as claimed in any preceding claim, wherein the apparatus further comprises a third test unit, the third test unit comprising:

- radio transceiver circuitry for communicating with a respective third one of the multiple mobile communication networks;
- a network authentication device for the third network;
- control circuitry for (i) maintaining a call over the third network using the antenna and radio transceiver circuitry; and (ii) measuring the performance of the third network during the call; and

wherein the apparatus further comprises means for controlling the first, second and third test units to maintain calls over their respective networks and to measure the performance of their respective networks at substantially the same time.
# INTERNATIONAL SEARCH REPORT

## A. CLASSIFICATION OF SUBJECT MATTER
**HO4Q7/34**

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)

HO4Q H01Q H03H

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 practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>X</td>
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**X** Further documents are listed in the continuation box C. **X** Patent family members are listed in annex.

* Special categories of cited documents:
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Date of the actual completion of the international search

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Name and mailing address of the ISA

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