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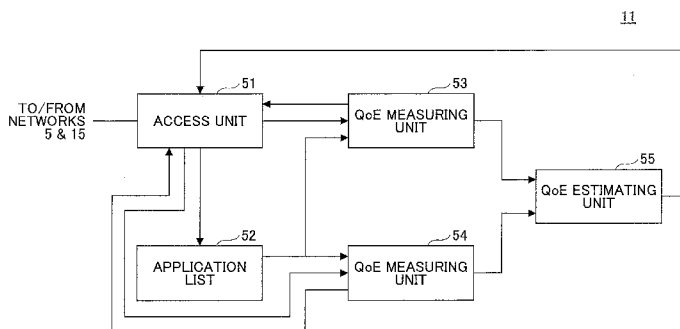
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FIG.5



(57) Abstract: A method of notifying estimated QoEs (Quality of Experiences) for applications between a mobile terminal and a plurality of application servers that provide services of the applications, may measure first QoEs for the applications between the apparatus and the mobile terminal, measure second QoEs for the applications between the apparatus and the application server, estimate the estimated QoEs for the applications, based on the first and second QoEs for the applications, and notify the estimated QoEs to the mobile terminal.

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DESCRIPTION

TITLE

APPARATUS, MOBILE TERMINAL, AND METHOD TO
ESTIMATE QUALITY OF EXPERIENCE OF APPLICATION

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TECHNICAL FIELD

The disclosure relates to a technology to
estimate a QoE (Quality of Experience) of
application software (hereinafter simply referred to
as "application") between a mobile terminal and an
application server.

10

BACKGROUND ART

Unless otherwise indicated herein, the
approaches described in this section are not prior
art to the claims in this application and are not
admitted to be prior art by inclusion in this
section .

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A mobile terminal may use an application
to receive services of the application from an
application server. For example, the application
may be related to e-mail, IP (Internet Protocol)
telephony, IP audio and/or video distribution or
broadcasting, video conferencing, map searching, etc.
The mobile terminal may observe a status of radio
wave reception from a network provider or a wireless
LAN (Local Area Network), for example, in order to
ascertain a bandwidth currently available to the
mobile terminal. A user (or operator) of the mobile
terminal may determine whether to use the
application based on the radio wave reception status.

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However, with the observation of the radio
wave reception status of the mobile terminal, it may
not be possible to ascertain the QoE of the
application between the mobile terminal and the
application server providing the services of the
application.

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The QoE may sometimes also be referred to as "quality of user experience", and is a subjective and/or objective measure of a user's (or customer's) experiences with a service. The QoE may be related to Quality of Service (QoS), but differs from the QoS.

SUMMARY

One aspect of the embodiment may provide a technology for estimating the QoE of application between a mobile terminal and an application server.

According to another aspect of the embodiment, an apparatus communicatable with an application server and a mobile terminal, may include a first measuring unit configured to measure a first QoE (Quality of Experience) for an application between the apparatus and the mobile terminal based on information related to the application; and an estimating unit configured to estimate, based on the first QoE for the application and a second QoE for the application between the apparatus and the application server that provides services of the application, a third QoE for the application between the mobile terminal and the application server.

According to still another aspect of the embodiment, a mobile terminal communicatable with a base station, may include a transmitter /receiver configured to send information related to a plurality of applications that are executable in the mobile terminal to the base station and to receive from the base station QoEs (Quality of Experiences) for the plurality of applications between the mobile terminal and a plurality of application servers that provide services of the plurality of applications; a display unit configured to display the QoEs for the plurality of applications received by the

transmitter/receiver; and a control unit configured to control the transmitter /receiver in order to periodically send the information related to the plurality of applications to the base station.

5 According to a further aspect of the embodiment, a method of notifying estimated QoEs (Quality of Experiences) for a plurality of applications between a mobile terminal and a plurality of application servers that provide
10 services of the plurality of applications, may include measuring first QoEs for the plurality of applications between the apparatus and the mobile terminal; measuring second QoEs for the plurality of applications between the apparatus and the
15 application server; estimating the estimated QoEs for the plurality of applications, based on the first QoEs for the plurality of applications and the second QoEs for the plurality of applications; and notifying the estimated QoEs to the mobile terminal.

20 The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and further features will be apparent
25 from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

30 Subject matter is particularly pointed out and distinctly claimed in the concluding portion of the specification. The foregoing and other features of the present disclosure will become more fully apparent from the following detailed description and appended claims, taken in conjunction with the
35 accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are, therefore,

not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings .

5 FIG. 1 is a block diagram illustrating an example of a communication system in an embodiment;

 FIG. 2 is a block diagram illustrating an example of an application server;

10 FIG. 3 is a block diagram illustrating an example of a base station;

 FIG. 4 is a block diagram illustrating an example of a mobile terminal;

 FIG. 5 is a functional block diagram illustrating an example of the base station;

15 FIG. 6 is a functional block diagram illustrating an example of the mobile terminal;

 FIG. 7 is a diagram for explaining an example of a video distribution provided by an application; and

20 FIG. 8 is a diagram illustrating an example of a display of QoEs on the mobile terminal, all arranged in accordance with the present disclosure .

25 DETAILED DESCRIPTION

 In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, 30 unless context dictates otherwise. The illustrative examples or embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other examples or embodiments may be utilized, and other changes may be made, without 35 departing from the spirit or scope of the subject matter presented here. It may be readily understood that aspects of this disclosure, as generally

described herein, and illustrated in the Figures, may be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and make part
5 of this disclosure.

This disclosure is drawn, inter alia, to apparatuses, mobile terminals, and methods related to estimating the QoE (Quality of Experience) of application between a mobile terminal and an
10 application server.

Briefly stated, techniques are generally described herein for QoE estimation.

FIG. 1 is a block diagram illustrating an example of a communication system in an embodiment.
15 The communication system illustrated in FIG. 1 may include a plurality of application servers 1-1 through 1-N (N is a natural number greater than or equal to 2), a base station 11, and a plurality of mobile terminals 21-1 through 21-M (M is a natural
20 number greater than or equal to 2). Each application server 1- i ($i = 1, \dots, N$) may provide services of at least one arbitrary application. For example, the application may be related to e-mail, IP telephony, IP audio and/or video distribution or
25 broadcasting, video conferencing, map searching, etc. The base station 11 and each application server 1- i may communicate via a network 5. The network 5 may include a cable network, a wireless network, or a combination of cable and wireless networks. In
30 addition, the network 5 may include the Internet. The base station 11 and each mobile terminal 21- j ($j = 1, \dots, M$) may communicate via a wireless network 15.

The base station 11 may communicate with a
35 cloud computing system including the plurality of application servers 1-1 through 1-N that provide the services of a plurality of applications.

FIG. 2 is a block diagram illustrating an example of the application server. The application server 1-i illustrated in FIG. 2 may include a CPU (Central Processing Unit) 101 as an example of a processor, a storage unit 102, an input unit 103, a display unit 104, and a transmitter and receiver (hereinafter "transmitter/receiver") 105 that are connected via a bus 106. Instead of using the bus 106, the CPU 101 may be connected directly to another part of the application server 1-i, such as the input unit 103 and the display unit 104.

The CPU 101 may control operations of the application server 1-i, including an operation to provide services of the application provided by the application server 1-i, by executing programs.

For example, the storage unit 102 may be formed by a semiconductor memory device, a drive unit, and the like, in order to store the programs to be executed the CPU 101 and various data, including parameters and intermediate data obtained when operations are performed by the CPU 101. The drive unit may include or, be detachably loaded with a recording medium, such as a disk medium. For example, the disk medium may be formed by a magnetic disk, an optical disk or, a magneto-optical disk.

The input unit 103 may be formed by a keyboard, a mouse, or the like, in order to input data and instructions to the CPU 101. The display unit 104 may be formed by a LCD (Liquid Crystal Display) or the like, in order to display messages, the QoE of the applications, and the like. The input unit 103 and the display unit 104 may be formed integrally, by a touch-screen panel, for example.

The transmitter/receiver 105 includes a function to transmit data to and receive data from the network 5.

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FIG. 3 is a block diagram illustrating an example of the base station. The base station 11 illustrated in FIG. 3 may include a CPU 111 as an example of a processor, a storage unit 112, an input unit 113, a display unit 114, and a transmitter /receiver 115 that are connected via a bus 116. Instead of using the bus 116, the CPU 111 may be connected directly to another part of the base station 11, such as the input unit 113 and the display unit 114.

The CPU 111 may control operations of the base station 11, including at least an operation to measure the QoE of the application between the base station 11 and the application server 1-i providing services of the application, an operation to communicate with the application servers 1-1 through 1-N, and an operation to communicate with the mobile terminals 21-1 through 21-M, by executing programs. The CPU 111 may control an operation to measure the QoE of the application between the base station 11 and the mobile terminal 21-j that may use the application, by executing a program. The CPU 111 may control an operation to estimate the QoE of the application between the mobile terminal 21-j that may use the application and the application server 1-i providing services of the application, by executing a program.

For example, the storage unit 112 may be formed by a semiconductor memory device, a drive unit, and the like, in order to store the programs to be executed the CPU 111 and various data, including a list of applications, parameters and intermediate data obtained when operations are performed by the CPU 111. The input unit 113 may be formed by a keyboard, a mouse, or the like. The display unit 114 may be formed by a LCD or the like. The input unit 113 and the display unit 114 may be

formed integrally, by a touch-screen panel, for example .

The transmitter/receiver 115 includes a function to transmit data to and receive data from the network 5, and to transmit data to and receive data from the network 15.

FIG. 4 is a block diagram illustrating an example of the mobile terminal. The mobile terminal 21-j illustrated in FIG. 4 may include a CPU 211 as an example of a processor, a storage unit 212, an input unit 213, a display unit 214, and a transmitter /receiver 215 that are connected via a bus 216. Instead of using the bus 216, the CPU 211 may be connected directly to another part of the mobile terminal 21-j, such as the input unit 213 and the display unit 214.

The CPU 211 may control operations of the mobile terminal 21-j, including at least an operation to communicate with the base station 11, by executing a program. The CPU 211 may control an operation to notify the list of applications that may be used (or are usable) by the mobile terminal 21-j, to the base station 11, by executing a program. The CPU 211 may control an operation to measure the QoE of the application, that may be used by the mobile terminal 21-j, between the mobile terminal 21-j and the base station 11, by executing a program. The CPU 211 may control operations to acquire the QoE of the application, that may be used by the mobile terminal 21-j, between the base station 11 and the application server 1-i providing services of the application, and to estimate the QoE of the application between the mobile terminal 21-j and the application server 1-i, by executing a program.

For example, the storage unit 212 may be formed by a semiconductor memory device, a drive unit, and the like, in order to store the programs

to be executed the CPU 211 and various data, parameters and intermediate data obtained when operations are performed by the CPU 211. The storage unit 212 may store the list of applications
5 that may be used by the mobile terminal 21-j. The input unit 213 may be formed by a keyboard, a mouse, or the like. The display unit 214 may be formed by a LCD (Liquid Crystal Display) or the like, in order to display messages for a user (or operator) of the
10 mobile terminal 21-j, including the QoE of the application, that may be used by the mobile terminal 21-j, between the mobile terminal 21-j and the application server 1-i providing services of the application. The input unit 213 and the display
15 unit 214 may be formed integrally, by a touch-screen panel, for example.

The transmitter/receiver 215 includes a function to transmit data to and receive data from the network 15.

20 FIG. 5 is a functional block diagram illustrating an example of the base station. FIG. 5 illustrates the functional structure of the base station 11 for an example in which the base station 11 performs a process including the following steps
25 si) through s3) .

Step si) Measuring the QoE of the application, that may be used by the mobile terminal 21-j, between the base station 11 and the application server 1-i providing services of the application;

30 Step s2) Measuring the QoE of the application, that may be used by the mobile terminal 21-j, between the base station 11 and the mobile terminal 21-j ; and

Step s3) Estimating the QoE of the application,
35 that may be used by the mobile terminal 21-j, between the mobile terminal 21-j and the application server 1-i providing services of the application.

For example, the estimated QoE having a level or value greater than a predetermined value may indicate that the mobile terminal 21-j may receive the service with a high quality. On the other hand, the estimated QoE having a level or value less than or equal to the predetermined value may indicate that the mobile terminal 21-j may only receive the service with a low quality. In a case in which the application provides video distribution, for example, the video information may be viewed at the mobile terminal 21-j with a high quality (or high frame rate) when the level of the estimated QoE is high, and only with a low quality (or low frame rate) when the level of the estimated QoE is low.

The base station 11 illustrated in FIG. 5 may include an access unit (or module) 51, an application list 52, a QoE measuring unit (or module) 53, a QoE measuring unit (or module) 54, and a QoE estimating unit (or module) 55. For example, the access unit 51 may be formed by the transmitter /receiver 115, and the application list 52 may be stored in the storage unit 112. The QoE measuring units 53 and 54, and the QoE estimating unit 55 may be formed by the CPU 111.

The access unit 51 may receive, from the mobile terminal 21-j, a notification indicating the application that may be used by the mobile terminal 21-j or, a list of applications that may be used by the mobile terminal 21-j. For example, the mobile terminal 21-j may send the notification to the base station 11 when the mobile terminal 21-j enters a coverage area of the base station 11. In addition, the mobile terminal 21-j may send the notification periodically to the base station 11. The access unit 51 may store the application or the list of applications indicated by the notification from the mobile terminal 21-j, in the application list 52.

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In a case in which the applications that may be used by the mobile terminal 21-j are known in advance, for example, the list of applications that may be used by the mobile terminal 21-j may be
5 prestored in the application list 52. In this case, the notification from the mobile terminal 21-j may be unnecessary.

The QoE measuring unit 53 measures, for each application in the application list 52, the QoE
10 between the base station 11 and each application server 1-i providing the services of each application. The QoE measuring unit 53 may measure the QoE periodically, for example. The QoE measuring unit 53 may actually download at least a
15 part of each application and/or use each application or, send a test packet or the like for performance measurement, by communicating with each application server 1-i providing the services of each application via the access unit 51 and the network 5.
20 In addition, the QoE measuring unit 53 may measure at least one of a bandwidth, a time delay, a jitter, and a loss of the application between the base station 11 and each application server 1-i. The QoE measured by the QoE measuring unit 53 may be stored
25 in the storage unit 112, for example.

On the other hand, the QoE measuring unit 54 measures, for each application in the application list 52, the QoE between the base station 11 and the mobile terminal 21-j that may use each application.
30 The QoE measuring unit 54 may measure the QoE periodically, for example. The QoE measuring unit 54 may actually download at least a part of each application and/or use each application or, send a test packet or the like for performance measurement,
35 by communicating with each application server 1-i providing the services of each application via the access unit 51 and the network 5, and by

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communicating with the mobile terminal 21-j via the network 15. In addition, the QoE measuring unit 54 may measure at least one of a bandwidth, a time delay, a jitter, and a loss of the application
5 between the base station 11 and the mobile terminal 21-j. The QoE measured by the QoE measuring unit 54 may be stored in the storage unit 112, for example.

The QoE measuring units 53 and 54 may form a single QoE measuring unit in order to eliminate a
10 redundant process of the QoE measuring units 53 and 54 that actually downloads at least a part of each application and/or uses each application or, send a test packet or the like for performance measurement, by communicating with each application server 1-i
15 providing the services of each application via the access unit 51 and the network 5. Alternatively, the QoE measuring unit 54 may utilize at least a part of each application actually downloaded by the QoE measuring unit 53 or, utilize the test packet or
20 the like sent for performance measurement by the QoE measuring unit 53, in order to measure at least one of the bandwidth, the time delay, the jitter, and the loss of the application between the base station 11 and the mobile terminal 21-j.

25 The QoE estimating unit 55 estimates the QoE of each application between the mobile terminal 21-j and the application server 1-i providing the services of each application, based on the QoEs measured by the QoE measuring units 53 and 54, and
30 notifies the estimated QoE to the mobile terminal 21-j via the access unit 51. The QoE estimating unit 55 may store the estimated QoE in the storage unit 112, for example. The mobile terminal 21-j may display on the display unit 214 thereof the
35 estimated QoE of each application between the mobile terminal 21-j and the application server 1-i providing the services of each application, notified

from the base station 11.

When estimating the QoE based on the bandwidths, the QoE estimating unit 55 may estimate the QoE based on a lower one of the QoEs measured in the QoE measuring units 53 and 54. When measuring the bandwidth as the QoE, the QoE estimating unit 55 may estimate the QoE based on a smaller one of the QoEs measured in the QoE measuring units 53 and 54. When measuring the any one or a combination of the time delay, the jitter, and the loss of the application as the QoE, the QoE estimating unit 55 may estimate the QoE based on a sum of the QoEs measured in the QoE measuring units 53 and 54. When measuring the jitter as the QoE, the QoE estimating unit 55 may estimate the QoE based on a convolution of jitter distributions measured as the QoEs in the QoE measuring units 53 and 54.

In a case in which the mobile terminal 21-j measures the QoE of each application between the mobile terminal 21-j and the base station 11, the QoE measuring unit 54 of the base station 11 may be omitted. In this case, the mobile terminal 21-j may notify at an arbitrary timing or, periodically, the QoE of each application between the mobile terminal 21-j and the base station 11 to the base station 11.

In a case in which the mobile terminal 21-j measures the QoE of each application between the mobile terminal 21-j and the base station 11 and also estimates the QoE of each application between the mobile terminal 21-j and the application server 1-i providing the services of each application, the QoE measuring unit 54 and the QoE estimating unit 55 of the base station 11 may be omitted. In this case, the QoE measuring unit 53 of the base station 11 may notify at an arbitrary timing or, periodically, the QoE between the base station 11 and the application server 1-i providing the services of each

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application to the mobile terminal 21-j via the access unit 51. Further, the mobile terminal 21-j may display on the display unit 214 thereof the estimated QoE of each application between the mobile terminal 21-j and the application server 1-i providing the services of each application, estimated in the mobile terminal 21-j using the QoE between the base station 11 and the application server 1-i providing the services of each application, notified from the base station 11.

FIG. 6 is a functional block diagram illustrating an example of the mobile terminal. FIG. 6 illustrates the functional structure of the mobile terminal 21-j for an example in which the mobile terminal 21-j performs a process including the following steps s11) through s13).

Step s11) Acquiring from the base station 11 the QoE of the application, that may be used by the mobile terminal 21-j, between the base station 11 and the application server 1-i providing services of the application;

Step s12) Measuring the QoE of the application, that may be used by the mobile terminal 21-j, between the mobile terminal 21-j and the base station 11; and

Step s13) Estimating the QoE of the application, that may be used by the mobile terminal 21-j, between the mobile terminal 21-j and the application server 1-i providing services of the application.

The mobile terminal 21-j illustrated in FIG. 6 may include an access unit (or module) 21, a QoE table 22, a QoE measuring unit (or module) 23, a QoE estimating unit (or module) 24, and the display unit 204. For example, the access unit 21 may be formed by the transmitter /receiver 215, and the QoE table 22 may be stored in the storage unit 212. The

QoE measuring unit 23 and the QoE estimating unit 24 may be formed by the CPU 211. A process performed by the QoE measuring unit 23 corresponds to that performed by the QoE measuring unit 54 of the base station 11, and a process performed by the QoE estimating unit 24 corresponds to that performed by the QoE estimating unit 55 of the base station 11.

The access unit 21 may receive, from the base station 11, a notification indicating the QoE of each application that may be used by the mobile terminal 21-j or, a list of applications that may be used by the mobile terminal 21-j, between the base station 11 and the application server 1-i providing the services of each application. For example, the base station 11 may send the notification to the mobile terminal 21-j when the mobile terminal 21-j enters the coverage area of the base station 11. In addition, the base station 11 may send the notification periodically to the mobile terminal 21-j. The access unit 21 may store the QoE of each application or the QoEs of the list of applications indicated by the notification from the base station 11, in the QoE table 22.

In a case in which the applications that may be used by the mobile terminal 21-j are known in advance, for example, the list of applications that may be used by the mobile terminal 21-j may be prestored as an application list. This application list may be prestored in the QoE table 22. In this case, the QoE notified from the base station 11 may be stored in the QoE table 22 in correspondence with the application list prestored therein. Of course, the QoE table 22 and the application list may be stored separately in the storage unit 212, for example.

The QoE measuring unit 23 measures, for each application in the application list, the QoE

between the mobile terminal 21-j and the base station 11. The QoE measuring unit 23 may measure the QoE periodically, for example. The QoE measuring unit 23 may actually download at least a part of each application and/or use each application or, send a test packet or the like for performance measurement, by communicating with each application server 1-i providing the services of each application via the base station 11, by communicating with the base station 11 via the access unit 21 and the network 15. In addition, the QoE measuring unit 23 may measure at least one of a bandwidth, a time delay, a jitter, and a loss of the application between the mobile terminal 21-j and the base station 11. The QoE measured by the QoE measuring unit 23 may be stored in the storage unit 212, for example.

The QoE estimating unit 24 estimates the QoE of each application between the mobile terminal 21-j and the application server 1-i providing the services of each application, based on the QoE notified from the base station 11 and the QoE measured by the QoE measuring unit 23, and notifies the estimated QoE to the display unit 204 to be displayed thereon. The QoE estimating unit 24 may store the estimated QoE in the storage unit 212, for example. For example, the display unit 214 may display the level of the estimated QoE of each application between the mobile terminal 21-j and the application server 1-i providing the services of each application, in a manner distinguishable by at least one of mutually different colors representing the QoEs, mutually different colors of icons representing the plurality of applications, mutually different sizes of icons representing the plurality of applications, and mutually different motions of icons representing the plurality of applications.

In a case in which the base station 11 measures the QoE of each application between base station 11 and the mobile terminal 21-j, the QoE measuring unit 23 of the mobile terminal 21-j may be omitted. In this case, the mobile terminal 21-j may receive at an arbitrary timing or, periodically, the QoE of each application between the base station 11 and the mobile terminal 21-j, from the base station 11.

In a case in which the base station 11 measures the QoE of each application between base station 11 and the mobile terminal 21-j and also estimates the QoE of each application between the mobile terminal 21-j and the application server 1-i providing the services of each application, the QoE measuring unit 23 and the QoE estimating unit 24 of the mobile terminal 21-j may be omitted. In this case, the access unit 21 of the mobile terminal 21-j may receive at an arbitrary timing or, periodically, the estimated QoE between the mobile terminal 21-j and the application server 1-i providing the services of each application from the base station 11. Further, the mobile terminal 21-j may display on the display unit 214 thereof the estimated QoE of each application between the mobile terminal 21-j and the application server 1-i providing the services of each application, received from the base station 11.

Next, a description will be given of examples of the methods of measuring the QoE. For the sake of convenience, a description will be given of the methods of measuring the QoE in the QoE measuring unit 53 of the base station 11. However, the methods of measuring the QoE in the QoE measuring unit 54 of the base station 11 and the methods of measuring the QoE in the QoE measuring unit 23 of the mobile terminal 21-j may be similar

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to that in the QoE measuring unit 53 of the base station 11, and a description thereof will be omitted .

The QoE measuring unit 53 may actually
5 download at least a part of each application (or at least a part of the services of each application) and/or use each application or, send a test packet or the like for performance measurement, by communicating with each application server 1-i
10 providing the services of each application via the network 5. In addition, the QoE measuring unit 53 may measure at least one of a bandwidth, a time delay, a jitter, and a loss of the application between the mobile terminal 21-j and the base
15 station 11.

As a first example, the QoE measuring unit 53 may perform a process including the following steps s21) through s23) .

Step s21) Sending a request for receiving a
20 service of the application or, a request for downloading at least a part of the application, to the application server 1-i providing this service or, to the cloud computing system including at least the application server 1-i providing this service.

25 Step s22) Receiving the service of the application or at least a part of the application, from the application server 1-i or, from the cloud computing system.

Step s23) Measuring the QoE based on the
30 received service of the application or the received part of the application. The QoE may be based on at least one of a bandwidth, a time delay, a jitter, and a loss of the service or the application. For example, the time delay may be a transfer time of
35 the service or the part of the application received from the application server 1-i or the cloud computing system, from a time when the request is

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sent from the base station 11. For example, the loss may be a packet loss rate of packets related to the service or the part of the application received from the application server 1-i or the cloud computing system.

The QoE measuring unit 54 may measure the QoE of the application between the base station 11 and the mobile terminal 21-j basically in the same manner as that of the QoE measuring unit 53.

However, the base station 11 and the mobile terminal 21-j may monitor a wireless communication rate therebetween. In this case, the QoE measuring unit 54 may measure the QoE based on the time delay detected from the wireless communication rate that is monitored by the base station 11 when the wireless communication rate is varied. Further, the QoE measuring unit 54 may measure the QoE based on the bandwidth detected from the highest wireless communication rate that is monitored by the base station 11 when the wireless communication rate is varied. Similarly, the QoE measuring unit 23 of the mobile terminal 21-j may measure the QoE based on the time delay or the bandwidth detected from the wireless communication rate monitored by the mobile terminal 21-j when the wireless communication rate is varied.

FIG. 7 is a diagram for explaining an example of the video distribution provided by the application. In FIG. 7, the illustration of the network 5 is omitted for the sake of convenience.

In this case, the step s21) sends a request for viewing video for testing to a cloud computing system 1000 including at least the application server 1-i providing this video testing service. The cloud computing system 1000 provides the service to distribute video data (or contents) including the video for testing (or a part of the

contents) . The step s22) receives the video for testing, responsive to the request for viewing the video for testing, from the cloud computing system 1000. The step s23) measures the QoE based on the video for testing received from the cloud computing system 1000. For example, the steps s21) through s23) may be performed periodically. The QoE may be based on at least one of a bandwidth, a time delay, a jitter, and a loss of the service or the application. For example, the time delay may be a transfer time of the video for testing received from the cloud computing system 1000, from a time when the request for viewing the video for testing is sent from the base station 11. For example, the loss may be a packet loss rate of packets related to the video for testing received from the cloud computing system 1000.

As a second example, the QoE measuring unit 53 may perform a process including the following steps s31) through s33), in a manner similar to the process proposed in a United States Patent No.7,929,450, for example.

Step s31) Sending a test packet or the like for performance measurement, such as a ping command, to the application server 1-i providing this service or, to the cloud computing system including at least the application server 1-i providing this service.

Step s32) Receiving a response to the test packet or the like for performance measurement, from the application server 1-i or, from the cloud computing system.

Step s33) Measuring the QoE based on the received response from the application server 1-i or, from the cloud computing system. The QoE may be based on at least one of a bandwidth, a time delay, a jitter, and a loss of the received response. For example, the time delay may be a transfer time of

the received response from the application server 1-i or the cloud computing system, from a time when the test packet or the like for performance measurement is sent from the base station 11. For example, the loss may be a packet loss rate of packets in the response received from the application server 1-i or the cloud computing system.

Of course, the method of measuring the QoE is not limited to the methods described above, and various other methods may be employed.

FIG. 8 is a diagram illustrating an example of a display of QoEs on the mobile terminal. The display unit 214 of the mobile terminal 21-j may display levels of the QoEs for the plurality of applications in a manner distinguishable by at least one of mutually different colors representing the QoEs, mutually different colors of icons representing the plurality of applications, mutually different sizes of icons representing the plurality of applications, and mutually different motions of icons representing the plurality of applications.

FIG. 8 illustrates the example in which the levels of the QoEs for a plurality of applications APL1 through APL7 are displayed in a manner distinguishable by mutually different colors representing the QoEs or, mutually different colors of icons representing the plurality of applications or, mutually different sizes of icons representing the plurality of applications. For example, blue (B), green (G), yellow (Y), red (R), and gray (GY) icons or application names displayed in such colors may respectively represent very good, good, fair, bad, and unavailable levels of the QoEs for the applications APL1 through APL7. In addition, the icons displayed with larger sizes may represent higher levels of the QoEs for the applications APL1 through APL7, for example. Further, the icons

displayed with the same color but with larger sizes may represent higher levels of the QoEs for the applications among the applications represented by the icons displayed with the same color, for example, 5 in order to represent a relatively large number of levels of the QoEs .

The required quality of communication may vary depending on the applications. Hence, when the levels of the QoEs for the applications are 10 displayed in a distinguishable manner on the display of the mobile terminal, the user of the mobile terminal may easily select a desired application based on the available levels of the QoEs for the applications .

15 When the QoE measuring unit 53 of the base station 11 estimates the QoE of the application between the base station 11 and the application server 1-i or the cloud computing system providing services of the application, the measured QoE may be 20 stored in the storage unit 112 and used in common by a plurality of mobile terminals that may use the same application and are located in the coverage area of the base station 11. In this case, the operation of measuring the QoE may be reduced 25 considerably when compared to a case in which the QoE of the application between the base station 11 and the application server 1-i or the cloud computing system is measured for one mobile terminal even if the QoE of this application between the base 30 station 11 and the application server 1-i or the cloud computing system has already been measured for another mobile terminal within the same coverage area of the base station 11. The effect of eliminating the need to measure the QoE of the same 35 application between the base station 11 and the application server 1-i or the cloud computing system separately for each of the mobile terminals located

within the coverage area of the base station 11 may be large, because the measurement of the QoE between the base station 11 and the application server 1-i or the cloud computing system is more complex and time-consuming compared the measurement of the QoE between the base station 11 and each mobile terminal, and the distance between the base station 11 and the application server 1-i or the cloud computing system is long compared to the distance between the base station 11 and each of the mobile terminals located within the coverage area of the base station 11.

In addition, the base station 11 may notify the QoEs estimated by the QoE estimating unit 55 for each of the applications that may be used by the mobile terminals located within the coverage area of the base station 11, to each of these mobile terminals located within the coverage area of the base station 11. Hence, each of the mobile terminals located within the coverage area of the base station 11 may dynamically and efficiently ascertain the QoEs of the individual applications that may be used thereby.

References made in this disclosure to the term "responsive to" or "in response to" are not limited to responsiveness to a particular feature and/or structure. A feature may also be responsive to another feature and/or structure and also be located within that feature and/or structure. Moreover, when terms or phrases such as "coupled" or "responsive" or "in response to" or "in communication with", etc. are used herein or in the claims that follow, these terms should be interpreted broadly. For example, the phrase "coupled to" may refer to being communicatively, electrically and/or operatively coupled as appropriate for the context in which the phrase is used.

Those skilled in the art will recognize that it is common within the art to describe devices and/or processes in the fashion set forth herein, and thereafter use engineering practices to

5 integrate such described devices (e.g., transmitters, receivers, wireless devices, computing platforms, computing devices, etc.) and/or methods into data processing systems. That is, at least a portion of the devices and/or methods described herein can be

10 integrated into a data processing system via a reasonable amount of experimentation. Those having skill in the art will recognize that a typical data processing system generally includes one or more of a system unit housing, a video display device, a

15 memory such as volatile and non-volatile memory, processors such as microprocessors and digital signal processors, computational entities such as operating systems, drivers, graphical user interfaces, and applications programs, one or more

20 interaction devices, such as a touch pad or screen, and/or control systems including feedback loops and control motors (e.g., feedback for sensing position and/or velocity; control motors for moving and/or adjusting components and/or quantities). A typical

25 data processing system may be implemented utilizing any suitable commercially available component, such as those typically found in data computing/-communication and/or network computing/communication systems.

30 The herein described subject matter sometimes illustrates different components or elements contained within, or connected with, different other components or elements. It is to be understood that such depicted architectures are

35 merely examples, and that in fact many other architectures can be implemented which achieve the same functionality. In a conceptual sense, any

arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality can be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated can also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality, and any two components capable of being so associated can also be viewed as being "operably couplable", to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically mateable and/or physically interacting components and/or wirelessly interactable and/or wirelessly interacting components and/or logically interacting and/or logically interactable components.

With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.) . It will be

further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to inventions containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should typically be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, typically means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In

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those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

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CLAIMS

1. An apparatus communicatable with an application server and a mobile terminal,
5 comprising:
 a first measuring unit configured to measure a first QoE (Quality of Experience) for an application between the apparatus and the mobile terminal based on information related to the application; and
10 an estimating unit configured to estimate, based on the first QoE for the application and a second QoE for the application between the apparatus and the application server that provides services of the application, a third QoE for the application
15 between the mobile terminal and the application server.
2. The apparatus as claimed in claim 1, further comprising:
20 a second measuring unit configured to measure the second QoE for the application.
3. The apparatus as claimed in claim 2, further comprising:
25 a storage configured to store the information related to the application.
4. The apparatus as claimed in claim 3, further comprising:
30 an access unit configured to communicate with the mobile terminal,
 wherein the access unit receives the information related to the application from the mobile terminal and stores the information in the
35 storage.
5. The apparatus as claimed in claim 4,

wherein the second measuring unit periodically measures the second QoE for the application based on the information related to the application.

5 6. The apparatus as claimed in claim 4, wherein the access unit sends the third QoE for the application to the mobile terminal.

10 7. The apparatus as claimed in claim 2, wherein the first and second measuring units respectively measure the first QoE and the second QoE for the application, based on at least one of a bandwidth, a time delay, a jitter, and a loss between the apparatus and the mobile terminal and
15 between the apparatus and the application server, respectively .

20 8. The apparatus as claimed in claim 7, wherein the estimating unit estimates the third QoE for the application by comparing the first and second QoEs for the application and obtaining a lower one of the first and second QoEs as the third QoE.

25 9. The apparatus as claimed in claim 2, wherein the second measuring unit communicates with a cloud computing system including a plurality of application servers that provide services of a plurality of applications.

30 10. The apparatus as claimed in claim 9, wherein

the first measuring unit measures the first QoE for each of the plurality of applications;

35 the second measuring unit measures the second QoE for each of the plurality of applications;

the estimating unit estimates the third QoE for

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each of the plurality of applications; and
the access unit sends the third QoE for each of
the plurality of applications to the mobile terminal.

5 11. A mobile terminal communicatable with
a base station, comprising:

 a transmitter/receiver configured to send
information related to a plurality of applications
that are executable in the mobile terminal to the
10 base station and to receive from the base station
QoEs (Quality of Experiences) for the plurality of
applications between the mobile terminal and a
plurality of application servers that provide
services of the plurality of applications;

15 a display unit configured to display the QoEs
for the plurality of applications received by the
transmitter /receiver ; and

 a control unit configured to control the
transmitter /receiver in order to periodically send
20 the information related to the plurality of
applications to the base station.

 12. The mobile terminal as claimed in
claim 11, wherein the QoEs for the plurality of
25 applications received from the base station are
based on at least one of a bandwidth, a time delay,
a jitter, and a loss between the mobile terminal and
the base station and between the base station and
the plurality of application servers.

30

 13. The mobile terminal as claimed in
claim 11, wherein the display unit displays levels
of the QoEs for the plurality of applications in a
manner distinguishable by at least one of:

35 mutually different colors representing the
QoEs;

 mutually different colors of icons representing

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the plurality of applications;
mutually different sizes of icons representing
the plurality of applications; and
mutually different motions of icons
5 representing the plurality of applications.

14. A method of notifying estimated QoEs
(Quality of Experiences) for a plurality of
applications between a mobile terminal and a
10 plurality of application servers that provide
services of the plurality of applications,
comprising :

measuring first QoEs for the plurality of
applications between the apparatus and the mobile
15 terminal;

measuring second QoEs for the plurality of
applications between the apparatus and the
application server;

estimating the estimated QoEs for the plurality
20 of applications, based on the first QoEs for the
plurality of applications and the second QoEs for
the plurality of applications; and

notifying the estimated QoEs to the mobile
terminal .

25

15. The method as claimed in claim 14,
wherein

the measuring first QoEs measures the first
QoEs in the base station based on information
30 related to the plurality of applications received
from the mobile terminal;

the measuring second QoEs measures the second
QoEs in the base station based on the information
related to the plurality of applications received
35 from the mobile terminal;

the estimating estimates the estimated QoEs in
the base station; and

the notifying notifies the estimated QoEs to the mobile terminal from the base station.

16. The method as claimed in claim 14,
5 wherein

the measuring first QoEs measures the first QoEs in the mobile terminal;

the measuring second QoEs measures the second QoEs in the base station based on information
10 related to the plurality of applications;

the estimating estimates the estimated QoEs in the mobile terminal based on the first QoEs measured in the mobile terminal and the second QoEs measured in and notified from the base station; and

15 the notifying notifies the estimated QoEs to the mobile terminal in order to trigger a display of the estimated QoEs on a display unit of the mobile terminal .

20 17. The method as claimed in claim 15, wherein the information related to the plurality of applications is stored in a storage of the base station .

25 18. The method as claimed in claim 15, further comprising:

periodically sending the information related to the plurality of applications from the mobile terminal to the base station.

30

19. The method as claimed in claim 14, wherein the measuring second QoEs measures the second QoEs periodically.

35 20. The method as claimed in claim 14, further comprising:

displaying, on a display unit of the mobile

terminal, levels of the estimated QoEs for the plurality of applications in a manner distinguishable by at least one of:

- 5 mutually different colors representing the estimated QoEs;
- mutually different colors of icons representing the plurality of applications;
- mutually different sizes of icons representing the plurality of applications; and
- 10 mutually different motions of icons representing the plurality of applications.

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FIG. 1

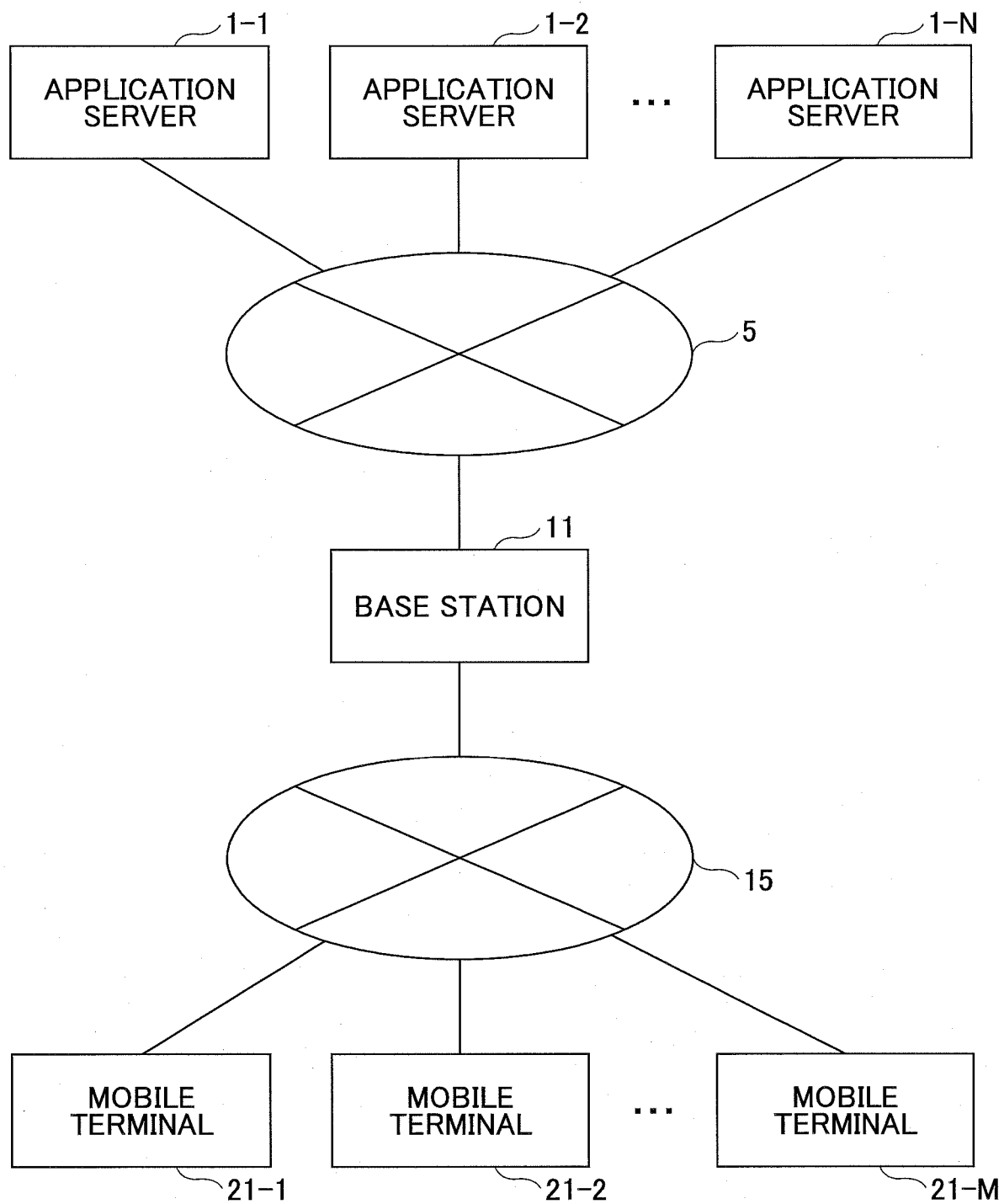


FIG.2

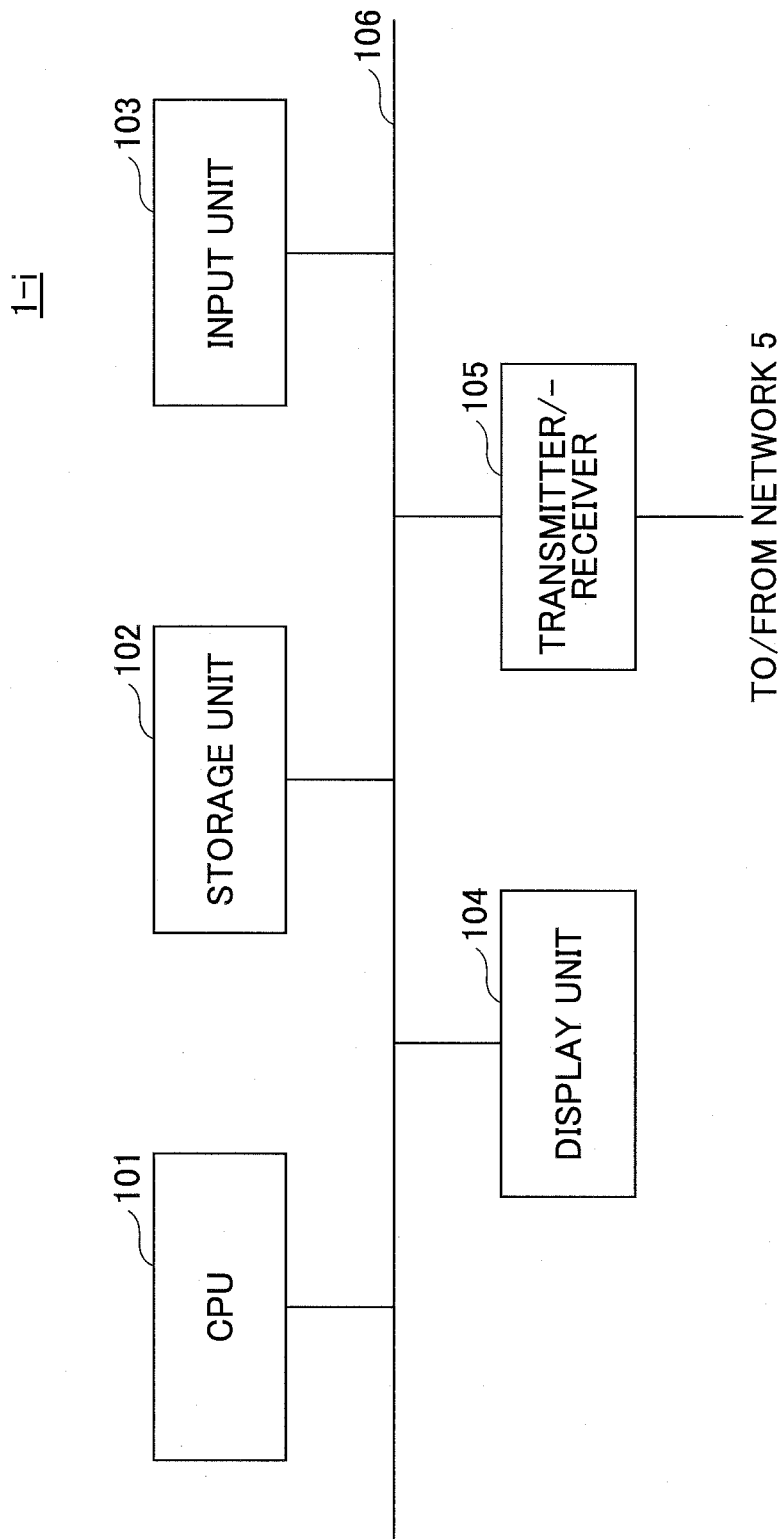


FIG.3

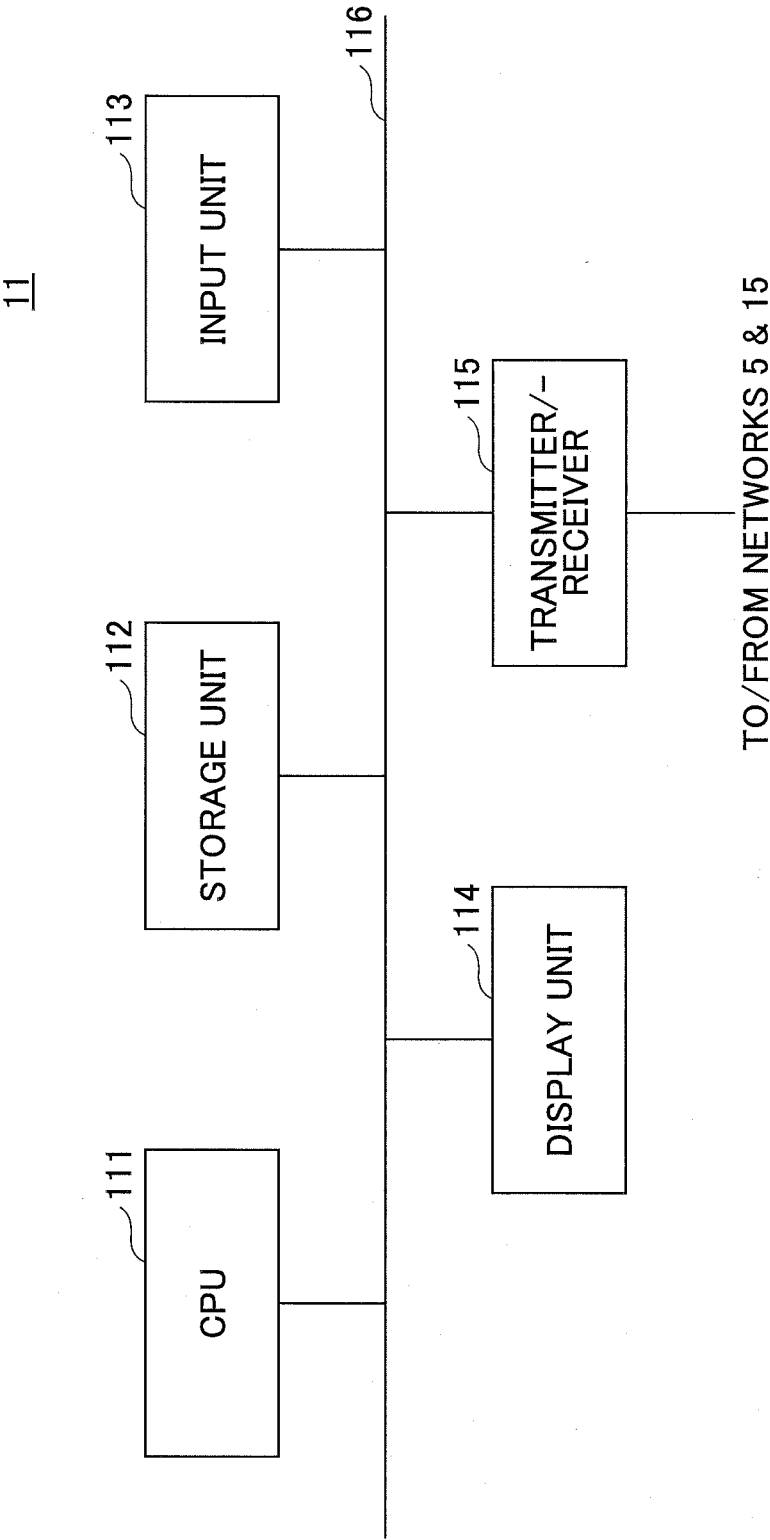
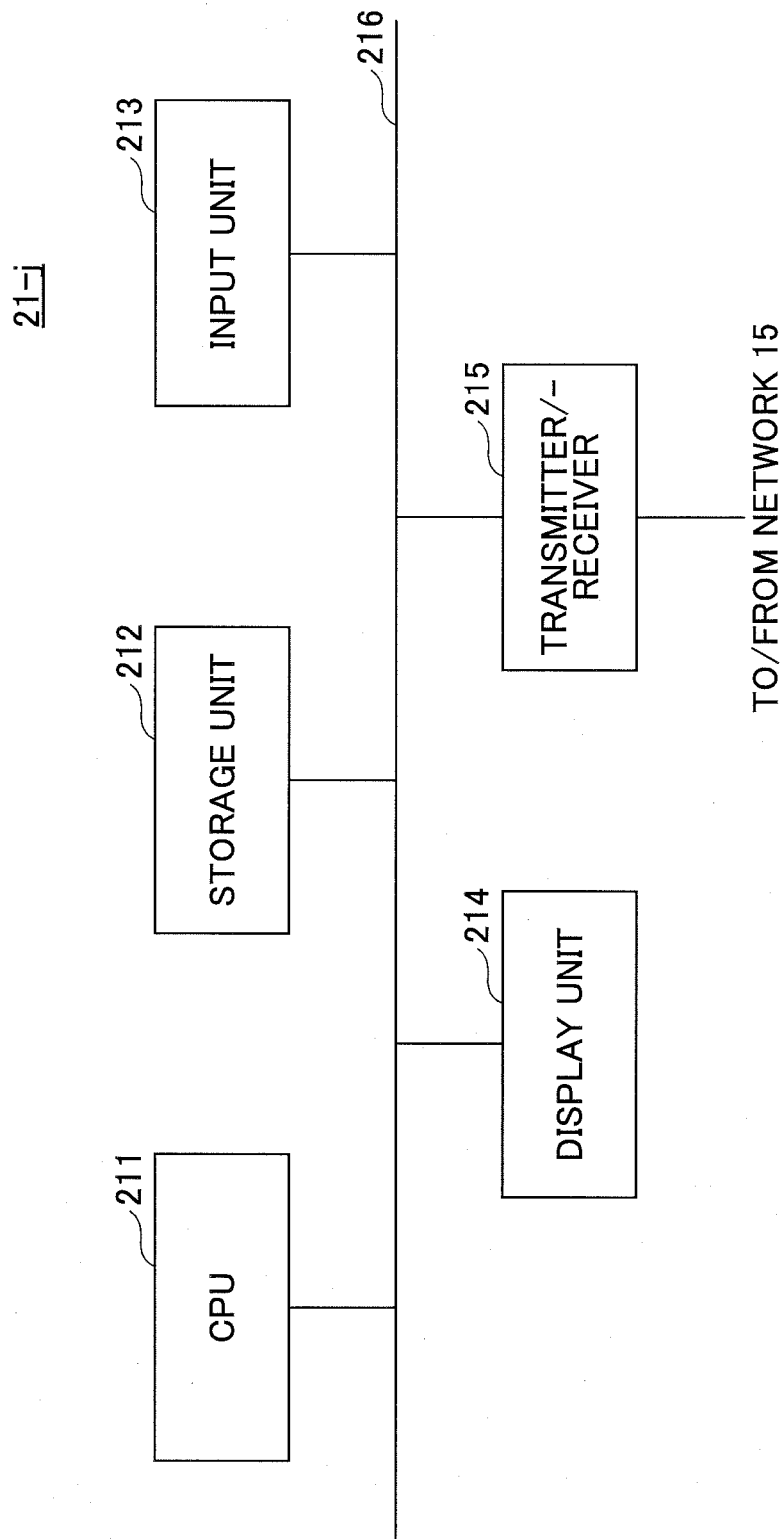


FIG.4



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FIG. 5

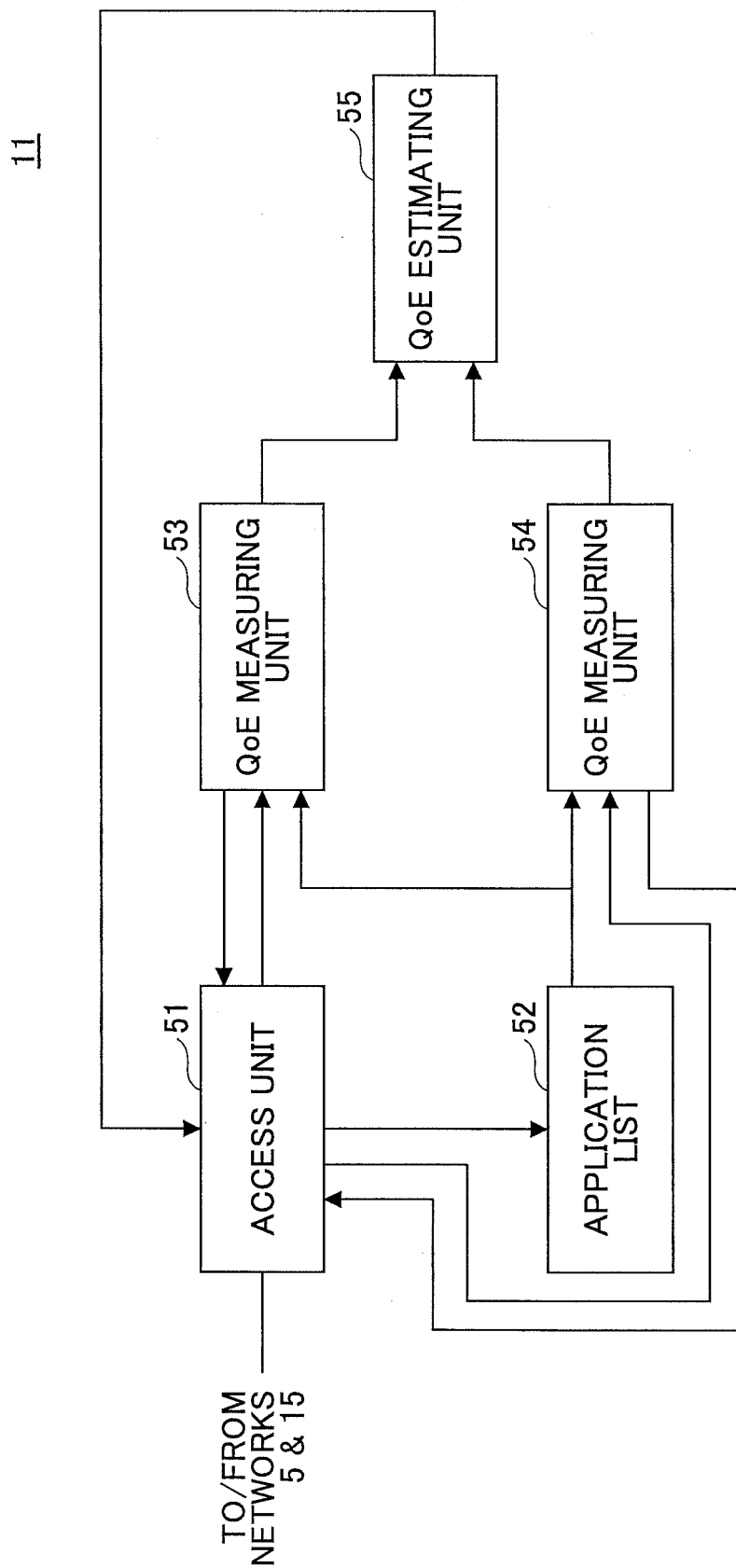
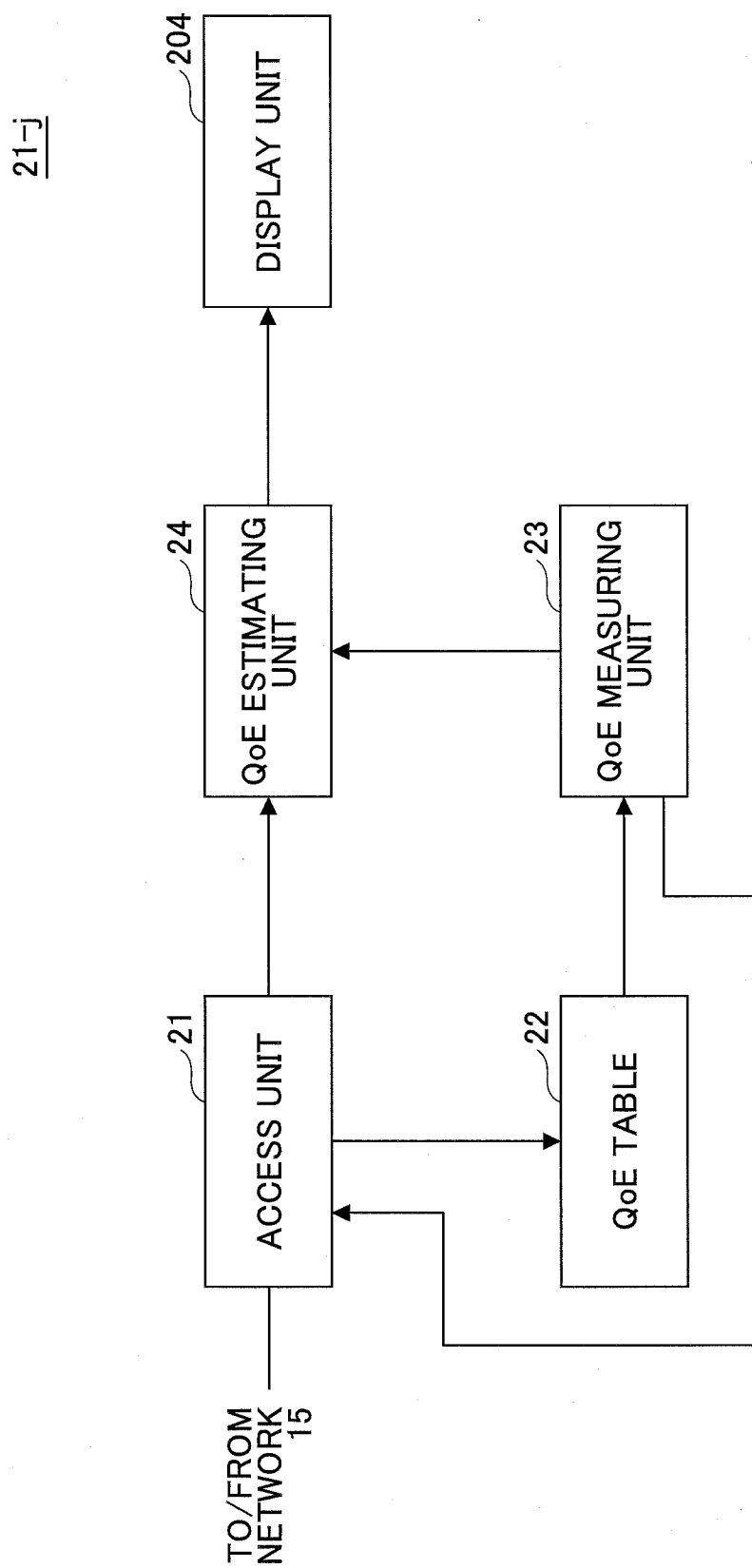
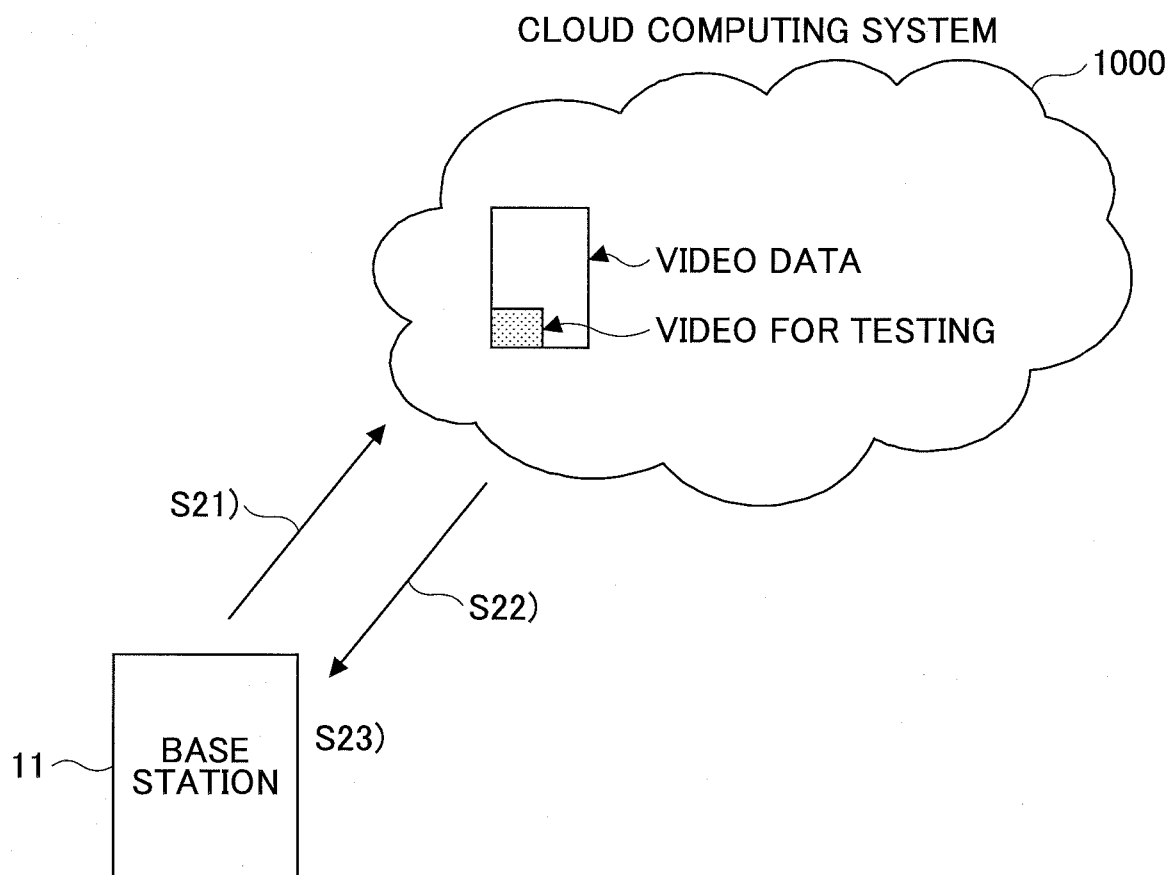


FIG.6



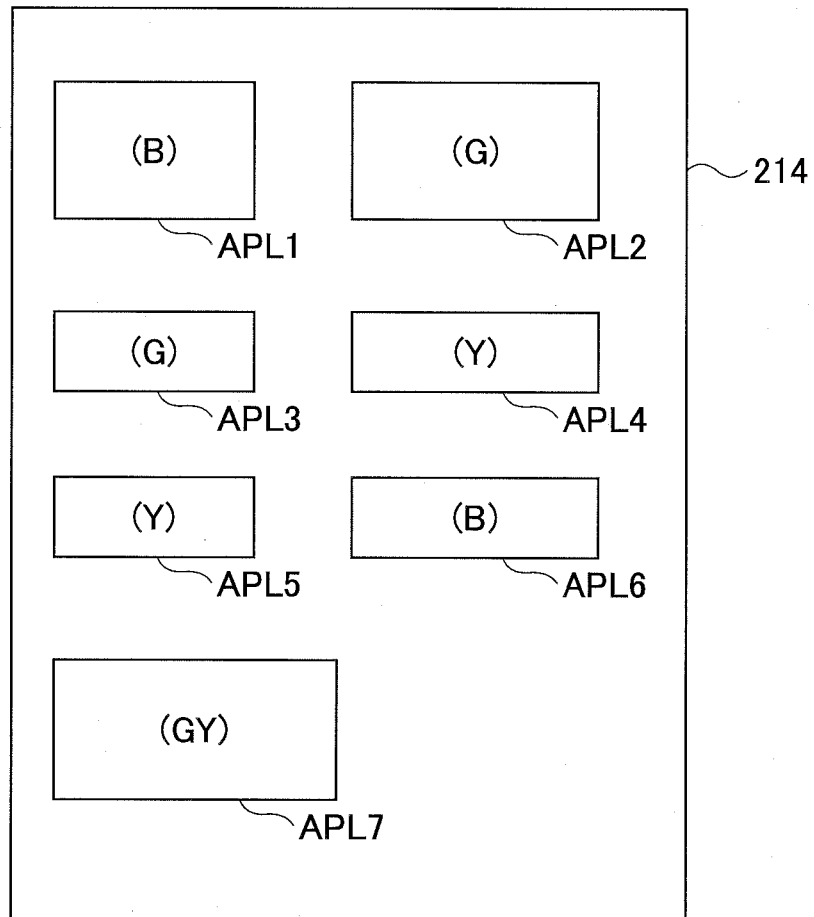
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FIG. 7



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FIG.8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US20 11/066702

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

H04W 28/16 (2009.01)**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)

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)

WPI, EPODOC, Google, Google Patents, Google Scholar with keywords including QoE, quality of experience, measure, estimate, mobile, cellular, wireless, application, server, software, cloud, calculate, predict and similar keywords.**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 201 1/02 11464 A1 (GHETLUR et al.) 1 September 2011 - See whole document, in particular the abstract, figure 4, paragraph [0054]	1-10, 14-20
A	US 201 1/0149775 A1 (LEE et al.) 23 June 2011 - See abstract	1-10, 14-20
A	US 201 1/0202593 A1 (VADERNA et al.) 18 August 2011 - See whole document, in particular see the abstract, figures 4 and 6	11-13

☐ Further documents are listed in the continuation of Box C

☒ See patent family annex

* Special categories of cited documents:			
"A"	document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
24 February 2012

Date of mailing of the international search report
7 March 2012

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/066702**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box I

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☒ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Supplemental Box I**(To be used when the space in any of Boxes I to IV is not sufficient)****Continuation of Box No: Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-10 and 14-20 are directed at a method of estimating QoEs (Quality of Experience) for a plurality of applications between a mobile terminal, a base station and application servers based on an initial measurement of a QoE. The feature of estimating QoEs based on an initially-measured QoE is specific to this group of claims.
- Claims 11-13 are directed at a mobile station periodically transmitting application information to a base station, and receiving and displaying QoE values for a plurality of applications running between the mobile terminal and a plurality of application servers. The features of sending application data and receiving and displaying QoEs in return are specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only feature common to all of the claimed inventions is the concept of QoEs representing the user's perception of the performance of applications run between mobile terminals and application servers. However it is considered that this feature is generic in this particular art.

Therefore this common feature cannot be a special technical feature. Hence there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied a priori.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US201 1/066702

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member
US	201121 1464	NONE
US	2011 149775	NONE
US	2011202593	NONE
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.		
END OF ANNEX		