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(54) **Title:** MONITORING OF LOAD BALANCING

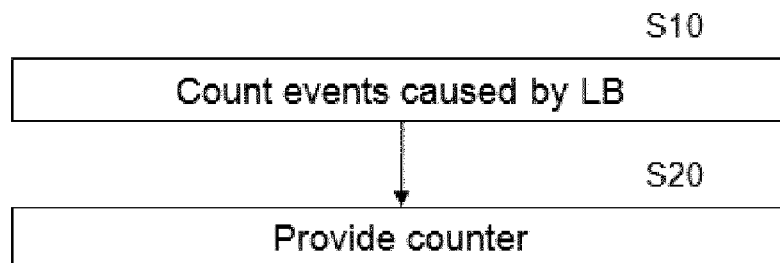


Fig. 2

(57) **Abstract:** It is provided a method, comprising counting, in at least one counter, a number of events of at least one kind caused by load-balancing, wherein the load-balancing balances a load between an apparatus performing the method and a cell device different from the apparatus; and providing the at least one counter to a management device.



Monitoring of load balancing

Field of the invention

5 The present invention relates to an apparatus, a method, and a computer program product related to mobile communication networks. More particularly, the present invention relates to an apparatus, a method, and a computer program product related to mobile load balancing.

10 Background of the invention

Abbreviations

	3G	3 rd generation
	3GPP	3 rd Generation Partnership Project
15	4G	4 th generation
	5G	5 th generation
	CDMA	Code Division Multiple Access
	CIO	Cell Individual Offset
	EDGE	Enhanced Data rates for Global Evolution
20	GBR	Guaranteed Bit Rate
	LB	Load Balancing
	LTE™	Long Term Evolution
	LTE-A™	Long Term Evolution- Advanced
	MLB	Mobility Load Balancing
25	NM	Network Management
	NMS	Network Management System
	OAM	Operation and Maintenance
	RAN	Radio Access Network
	SA	System Architecture (group)
30	SON	Self-Organizing Networks
	TS	Technical Specification
	TTT	Time to Trigger
	UE	User Equipment
	UMTS	Universal Mobile Telecommunication System
35	WCDMA	Wideband Code Division Multiplex Access
	WiFi™	Wireless Fidelity

The application is related to SON Load Balancing (in some cases, e.g. in RAN specification, it is also called Mobility Load Balancing). In the present application, LB and MLB are used synonymously, if not otherwise indicated or made clear from the context.

40

In 3GPP, Load Balancing is defined as a distributed SON feature (refer to 3GPP TS 36.300 and TS 36.423), with very limited OAM control and monitoring capability (as specified in 3GPP TS 32.522 and TS 32.762). The

5 Load Balancing functionality comprises 3 functions (the sequence listed below is not indicative for a sequence of performing the functions):

- Load information exchange (current load level and/or capacity offered for LB purposes);
- Handover execution; and
- 10 - Mobility setting adjustment.

MLB relies on periodical/on demand information exchange and parameter change procedures over the X2 interface (X2 interface: interface between (e)NodeBs). Operators expressed the requirement to move MLB

15 functionality at the NM level, in order to gain control of the feature operation, in particular in a multi-vendor environment. Essentially what operators are after is the capability to track and affect MLB performance.

3GPP TS 32.522, v11.6.1 defines some capabilities to control and monitor the distributed LB. In particular, some counters are defined in section 4.2.5

20 thereof. These counters are (purely) for evaluation of network performance, which is a result of MLB (inter alia). They are too limited to let operators know what LB has done.

3GPP TS 32.662 describes capturing SON information that triggered notifyAttributeValueChange notification by including SON operation information in additionalText field. However, this is an optional feature and support of LB action in this field cannot be guaranteed. Accordingly, in particular, in multivendor environment, operators cannot base their

30 judgement of MLB on this feature.

Summary of the invention

It is an object of the present invention to improve the prior art. In detail, it is an object to overcome at least some of the problems arising in particular in distributed MLB.

- 5 According to a first aspect of the invention, there is provided an apparatus, comprising counting means adapted to count, in at least one counter, a number of events of at least one kind caused by load-balancing, wherein the load-balancing balances a load between the apparatus and a cell device different from the apparatus; providing means adapted to provide the at
10 least one counter to a management device.

In the apparatus, for each of the at least one kinds of events, the number of events may be counted in a respective one of the at least one counters.

- 15 In the apparatus, the at least one kinds of events may comprise at least one of
- a mobility change request caused by the load balancing;
 - a mobility change failure, wherein the corresponding mobility change request is caused by the load balancing;
 - 20 — a mobility change acknowledge, wherein the corresponding mobility change request is caused by the load balancing;
 - an attempted handover preparation caused by the load balancing;
 - a rejected handover preparation, wherein the corresponding handover preparation is caused by the load balancing;
 - 25 — a successful handover preparation, wherein the corresponding handover preparation is caused by the load balancing; and
 - a failed handover, wherein the corresponding handover preparation is caused by the load balancing.

- 30 According to a second aspect of the invention, there is provided an apparatus, comprising measuring means adapted to measure a parameter related to user experience at a time when the user experience is potentially affected by load-balancing, wherein the load-balancing balances a load between the apparatus and a cell device different from the apparatus;

providing means adapted to provide a result of the measuring to a management device.

In the apparatus, the parameter may be at least one of an average
5 throughput of users served by the apparatus and a throughput of a fraction of the users served by the apparatus.

In the apparatus, the measuring means may be adapted to measure the parameter at a time when at least one of the following conditions is fulfilled:

- 10 1) the load is higher than a threshold relevant for the load balancing;
 and
 2) the time passed after a handover parameter change determining a probability of a handover is performed due to the load balancing is less than a maximum time.

15

According to a third aspect of the invention, there is provided an apparatus, comprising counting processor adapted to count, in at least one counter, a number of events of at least one kind caused by load-balancing, wherein the load-balancing balances a load between the apparatus and a cell device
20 different from the apparatus; providing processor adapted to provide the at least one counter to a management device.

In the apparatus, for each of the at least one kinds of events, the number of events may be counted in a respective one of the at least one counters.

25

In the apparatus, the at least one kinds of events may comprise at least one of

- a mobility change request caused by the load balancing;
- a mobility change failure, wherein the corresponding mobility change
30 request is caused by the load balancing;
- a mobility change acknowledge, wherein the corresponding mobility change request is caused by the load balancing;
- an attempted handover preparation caused by the load balancing;

- a rejected handover preparation, wherein the corresponding handover preparation is caused by the load balancing;
- a successful handover preparation, wherein the corresponding handover preparation is caused by the load balancing; and
- 5 – a failed handover, wherein the corresponding handover preparation is caused by the load balancing.

According to a fourth aspect of the invention, there is provided an apparatus, comprising measuring processor adapted to measure a
10 parameter related to user experience at a time when the user experience is potentially affected by load-balancing, wherein the load-balancing balances a load between the apparatus and a cell device different from the apparatus; providing processor adapted to provide a result of the measuring to a management device.

15

In the apparatus, the parameter may be at least one of an average throughput of users served by the apparatus and a throughput of a fraction of the users served by the apparatus.

- 20 In the apparatus, the measuring processor may be adapted to measure the parameter at a time when at least one of the following conditions is fulfilled:
- 3) the load is higher than a threshold relevant for the load balancing; and
 - 4) the time passed after a handover parameter change determining a
25 probability of a handover is performed due to the load balancing is less than a maximum time.

According to a fifth aspect of the invention, there is provided a base station, comprising an apparatus according to any of the first to fourth aspects,
30 wherein the load balancing is adapted to balance the load caused by at least one user served by the base station between the base station and the cell device. The base station may belong to a third generation partnership project standard.

According to a sixth aspect of the invention, there is provided an apparatus, comprising evaluating means adapted to evaluate at least one of a counter received from a first cell device and a measurement result received from the first cell device, wherein the counter counts a number of events of at least one kind caused by load-balancing, the measurement result is related to user experience at a time when the user experience is potentially affected by the load-balancing, and the load-balancing balances a load between the first cell device and a second cell device different from the first cell device; command generating means adapted to generate a command based on the evaluation of the at least one of the counter and the measurement result, wherein the command is adapted to modify the load-balancing of the first cell device.

In the apparatus, the command may comprise at least one of

- adjusting a load threshold of a first cell device for LB action;
- adjusting a first cell device or second cell device margin, indicating the minimum capacity that has to be reserved apart from the capacity allowed to be used for LB;
- adjusting an eagerness of the first cell device or second cell device for the load-balancing;
- switching off the load balancing of the first cell device;
- adjusting a cell individual offset of at least one of the first cell device and the second cell device.

The apparatus may further comprise providing means adapted to provide the command to at least one of the first cell device and the second cell device.

According to a seventh aspect of the invention, there is provided an apparatus, comprising evaluating processor adapted to evaluate at least one of a counter received from a first cell device and a measurement result received from the first cell device, wherein the counter counts a number of events of at least one kind caused by load-balancing, the measurement result is related to user experience at a time when the user experience is

potentially affected by the load-balancing, and the load-balancing balances a load between the first cell device and a second cell device different from the first cell device; command generating processor adapted to generate a command based on the evaluation of the at least one of the counter and the measurement result, wherein the command is adapted to modify the load-balancing of the first cell device.

In the apparatus, the command may comprise at least one of

- adjusting a load threshold of a first cell device for LB action;
- 10 - adjusting a first cell device or second cell device margin, indicating the minimum capacity that has to be reserved apart from the capacity allowed to be used for LB;
- adjusting an eagerness of the first cell device or second cell device for the load-balancing;
- 15 - switching off the load balancing of the first cell device;
- adjusting a cell individual offset of at least one of the first cell device and the second cell device.

The apparatus may further comprise providing processor adapted to provide the command to at least one of the first cell device and the second cell device.

According to an eighth aspect of the invention, there is provided an operation and maintenance center, comprising an apparatus according to any of the sixth and seventh aspects.

According to a ninth aspect of the invention, there is provided a method, comprising counting, in at least one counter, a number of events of at least one kind caused by load-balancing, wherein the load-balancing balances a load between the apparatus performing the method and a cell device different from the apparatus; providing the at least one counter to a management device.

In the method, for each of the at least one kinds of events, the number of events may be counted in a respective one of the at least one counters.

In the method, the at least one kinds of events may comprise at least one
5 of

- a mobility change request caused by the load balancing;
- a mobility change failure, wherein the corresponding mobility change request is caused by the load balancing;
- a mobility change acknowledge, wherein the corresponding mobility change request is caused by the load balancing;
- 10 – an attempted handover preparation caused by the load balancing;
- a rejected handover preparation, wherein the corresponding handover preparation is caused by the load balancing;
- a successful handover preparation, wherein the corresponding
15 handover preparation is caused by the load balancing; and
- a failed handover, wherein the corresponding handover preparation is caused by the load balancing.

According to a tenth aspect of the invention, there is provided a method,
20 comprising measuring a parameter related to user experience at a time when the user experience is potentially affected by load-balancing, wherein the load-balancing balances a load between an apparatus performing the method and a cell device different from the apparatus; providing a result of the measuring to a management device.

25

In the method, the parameter may be at least one of an average throughput of users served by the apparatus and a throughput of a fraction of the users served by the apparatus.

30 In the method, the measuring may be adapted to measure the parameter at a time when at least one of the following conditions is fulfilled:

- 1) the load is higher than a threshold relevant for the load balancing;
- and

2) the time passed after a handover parameter change determining a probability of a handover is performed due to the load balancing is less than a maximum time.

5 According to an eleventh aspect of the invention, there is provided a method, comprising evaluating at least one of a counter received from a first cell device and a measurement result received from the first cell device, wherein the counter counts a number of events of at least one kind caused by load-balancing, the measurement result is related to user
10 experience at a time when the user experience is potentially affected by the load-balancing, and the load-balancing balances a load between the first cell device and a second cell device different from the first cell device; generating a command based on the evaluation of the at least one of the counter and the measurement result, wherein the command is adapted to
15 modify the load-balancing of the first cell device.

In the method, the command may comprise at least one of

- adjusting a load threshold of a first cell device for LB action;
- adjusting a first cell device or second cell device margin, indicating
20 the minimum capacity that has to be reserved apart from the capacity allowed to be used for LB;
- adjusting an eagerness of the first cell device or second cell device for the load-balancing;
- switching off the load balancing of the first cell device;
- 25 - adjusting a cell individual offset of at least one of the first cell device and the second cell device.

The method may further comprise providing the command to at least one of the first cell device and the second cell device.

30

The method according to any of the ninth to eleventh aspects may be a method of monitoring load balancing.

According to a twelfth aspect of the invention, there is provided a computer program product comprising a set of instructions which, when executed on an apparatus, is configured to cause the apparatus to carry out the method according to any one of the ninth to eleventh aspects. The computer
5 program may be embodied as a computer-readable medium or directly loadable into a computer.

According to some embodiments of the invention, at least one of the following advantages may be achieved:

- 10 – operators get insight into MLB operation, even if distributed MLB is implemented;
- (Distributed and centralized) MLB operation may be controlled;
- User experience is improved in case of MLB; and
- the solution is applicable to multivendor environment.

15

It is to be understood that any of the above modifications can be applied singly or in combination to the respective aspects to which they refer, unless they are explicitly stated as excluding alternatives.

20 Brief description of the drawings

Further details, features, objects, and advantages are apparent from the following detailed description of the preferred embodiments of the present invention which is to be taken in conjunction with the appended drawings,
25 wherein

- Fig. 1 shows an apparatus according to an embodiment of the invention;
- Fig. 2 shows a method according to an embodiment of the invention;
- Fig. 3 shows an apparatus according to an embodiment of the invention;
- 30 Fig. 4 shows a method according to an embodiment of the invention;
- Fig. 5 shows an apparatus according to an embodiment of the invention;
- Fig. 6 shows a method according to an embodiment of the invention; and
- Fig. 7 shows an apparatus according to an embodiment of the invention.

Detailed description of certain embodiments

Herein below, certain embodiments of the present invention are described
5 in detail with reference to the accompanying drawings, wherein the features
of the embodiments can be freely combined with each other unless
otherwise described. However, it is to be expressly understood that the
description of certain embodiments is given for by way of example only, and
that it is by no way intended to be understood as limiting the invention to
10 the disclosed details.

Moreover, it is to be understood that the apparatus is configured to perform
the corresponding method, although in some cases only the apparatus or
only the method are described.

15

Based on the capabilities according to 3GPP TS 32.522 V11.6.1, at least the
following information is not known to the operator:

- How often did MLB attempt to perform;
- How often did a neighbour not permit the change of mobility
20 parameters for MLB, hence cause the MLB failed to perform;
- How often did MLB action cause the call drop or handover failure;
- The performance gained by end user from MLB.

Thus, it is difficult for the operator to clearly know when and how to control
25 the distributed MLB. It is even hard for them to justify the investment into
distributed MLB.

An alternative to implementing MLB in a centralised fashion (irrespective of
the feasibility of such a solution), is to gain the trust in the distributed MLB
30 implementation by providing more capabilities to monitor the performance
(e.g., for the aspects listed above) of distributed LB, and to affect its
operation from NM level.

According to some embodiments of the invention, eNB provides at least one of the following performance counters (measurement results) 1) to 9) to OAM. These counters are related to LB. Thus, the operator may track mobility load balancing operations and may control LB, thus affecting also
5 performance from user's point of view. The control may be made by the operator, or, automated, by the OAM system.

- 1) Number of MOBILITY CHANGE REQUEST for LB purpose;
- 2) Number of MOBILITY CHANGE FAILURE for LB purpose;
- 10 3) Number of MOBILITY CHANGE ACKNOWLEDGE for LB purpose;

Note that the MOBILITY CHANGE REQUEST could be also counted per handover offset. It is sufficient if two out of these three counters are implemented because the third one results from the other two.

15

- 4) Number of attempted handovers preparation related to LB
- 5) Number of rejected handovers preparation related to LB
- 6) Number of successful handovers preparation related to LB

20 It is sufficient if two out of these three counters are implemented because the third one results from the other two.

Whether or not a handover is related to MLB can be determined by eNB based on the capability specified in 3GPP TS 36.300 and TS 36.423.

25

In 3GPP TS 36.300, section 22.4.1.3 (Load balancing action based on handovers), the following capability is defined:

The source cell may initiate handover due to load (see sub-clauses 10.1.2 and 10.2.2). The target cell performs admission control for the
30 load balancing handovers. A handover preparation related to a mobility load balancing action shall be distinguishable from other handovers, so that the target cell is able to apply appropriate admission control.

According to 3GPP TS 36.423, section 9.2.6, the causes used in handover request could be Reduce Load in Serving Cell, Load Balancing etc.

5 Whether or not a handover (preparation) is related to MLB may also be determined by eNB by checking, if in case of a handover preparation, a certain condition is fulfilled. For instance, the condition could be that the handover preparation takes place after CIO change by LB and during the time that the cell load is always higher than the LB threshold. Another
10 condition could be that the handover preparation takes place during a time period after a CIO change due to LB. The conditions may be combined such that both conditions have to be fulfilled. The parameters of the conditions (e.g. LB threshold, time period) may be set by OAM.

15 7) Number of failed handovers related to LB

8) Average UE throughput of Non-GBR users during the time that the cell load is always higher than the LB threshold (settable by OAM) and/or during a time period (may be configurable) after a change of a parameter affecting LB (such as CIO).

20 9) Throughput of a certain fraction (e.g. 5th percentile) of Non-GBR users during the time that the cell load is always higher than the LB threshold (settable by OAM) and/or during a time period (may be configurable) after a change of a parameter affecting LB (such as CIO).

25

The performance counters 1) to 9) are collected at cell level and/or neighbour relation level. Performance counters 1) to 7) are counters counting a number of respective events, wherein the events are caused by load-balancing. Performance counters 8) and 9) measure a parameter
30 related to user experience at a time when the user experience is potentially affected by load-balancing.

With these performance measurements (together with the existing performance measurements in 32.522), operators could, via OAM, better monitor and control the MLB and improve MLB performance by adjusting some parameters. Some examples method (A to E) are given below how to
5 control the MLB or adjust the MLB settings based on evaluating a certain set of performance measurements (note that there may be more ways to use one or more of the above performance counters to control the MLB and/or adjust the MLB settings).

10 Example method A:

— If counter 1) is small while either call setup failure due to congestion (defined in 3GPP TS 32.522) or call drops caused by congestion (defined in 3GPP TS 32.522) is not low, OAM may adjust (e.g., decrease) the load/traffic threshold for MLB action;

15

Example method B:

— If counter 2) (or the difference of counters 1) and 3)) is high, OAM may adjust target cell's margin indicating the minimum capacity which has to be reserved apart from the capacity allowed to be used (for other cells) for
20 MLB.

Example method C:

25 If counter 5) is not small compared to counter 4) while call setup failure due to congestion (defined in 3GPP TS 32.522) or call drops caused by congestion (defined in 3GPP TS 32.522) is not low, OAM may adjust target cell's "eagerness" indicator which represents how much the cell is willing to impact existing serviced (non-GBR) when offering its available capacity for LB to other cells.

30 Example method D:

If counter 7) is not small compared to a fixed threshold (e.g. 1%), OAM may switch off the MLB to this neighbour and/or reduce the CIO (to avoid the potential mobility issues). In addition, OAM may adjust (decrease) the

another neighbour's margin (indicating the minimum capacity has to be reserved apart from the capacity allowed to be used (for other cells) for MLB) in order to offload more traffic to that neighbour.

5 Example method E:

If counter 8) or counter 9) or both are comparable with the case that the load is below the LB threshold while call setup failure due to congestion (defined in 3GPP TS 32.522) or call drops caused by congestion (defined in 3GPP TS 32.522) is low, OAM may switch off MLB.

10

Fig. 1 shows an apparatus according to an embodiment of the invention. The apparatus may be a cell device such as a base station (e.g. NodeB, eNodeB), or an element thereof. Fig. 2 shows a method according to an embodiment of the invention. The apparatus according to Fig. 1 may perform the method of Fig. 2 but is not limited to this method. The method of Fig. 2 may be performed by the apparatus of Fig. 1 but is not limited to being performed by this apparatus.

15

The apparatus comprises counting means 10 and providing means 20.

20

The counting means 10 counts a number of events (S10). The events may be of the same kind or of different kinds. The number of events may be counted in one counter (thus aggregating different kinds of events) or more counters. Preferably, there is a counter for each kind of event. Each of the events is caused (at least inter alia) by load balancing. The load-balancing balances a load (e.g. the load caused by terminal devices served by the apparatus) between the apparatus and a cell device different from the apparatus.

25

30 The providing means 20 provides the counter(s) to a management device. The management device may be a stand-alone device, or may be somehow integrated in an OAM or NMS system.

Fig. 3 shows an apparatus according to an embodiment of the invention. The apparatus may be a cell device such as a base station (e.g. NodeB, eNodeB), or an element thereof. Fig. 4 shows a method according to an embodiment of the invention. The apparatus according to Fig. 3 may perform the method of Fig. 4 but is not limited to this method. The method of Fig. 4 may be performed by the apparatus of Fig. 3 but is not limited to being performed by this apparatus.

The apparatus comprises measuring means 110 and providing means 120.

The measuring means 110 measures a parameter related to user experience at a time when the user experience is potentially affected by load-balancing (S110). The load-balancing balances a load (e.g. the load caused by terminal devices served by the apparatus) between the apparatus and a cell device different from the apparatus.

The providing means 120 provides the measurement result of the measuring means to a management device. The management device may be a stand-alone device, or may be somehow integrated in an OAM or NMS system.

Fig. 5 shows an apparatus according to an embodiment of the invention. The apparatus may be a control device such as a stand-alone control device, an OAM system, a NMS system, or an element thereof. Fig. 6 shows a method according to an embodiment of the invention. The apparatus according to Fig. 5 may perform the method of Fig. 6 but is not limited to this method. The method of Fig. 6 may be performed by the apparatus of Fig. 5 but is not limited to being performed by this apparatus.

The apparatus comprises evaluating means 210 and command generating means 220.

The evaluating means 210 evaluates at least one of a counter received from a first cell device (such as one according to Fig. 1) and/or a measurement result received from the first cell device (such as one according to Fig. 3) (S210). The counter counts a number of events of at least one kind caused by load-balancing. The measurement result is related to user experience at a time when the user experience is potentially affected by the load-balancing. The load-balancing balances a load (e.g. the load caused by terminal devices served by the first and second cell devices) between the first cell device and a second cell device different from the first cell device.

The command generating means 220 generates a command based on the evaluation of the at least one of the counter and the measurement result (S220). The command is adapted to modify the load-balancing of the first cell device. It may also be adapted to modify the load-balancing of the second cell device. The command may be provided to one or both of the first and second cell devices.

Fig. 7 shows an apparatus according to an embodiment of the invention.

The apparatus comprises at least one processor 310 and at least one memory 320 including computer program code. The at least one processor 310, with the at least one memory 320 and the computer program code, is arranged to cause the apparatus to at least perform at least one of the methods of Figs. 2, 4, and 6.

In embodiments of the invention, OAM system may be an existing OAM system into which the functionality according to embodiments of the invention is integrated, or a separate system (such as a stand-alone server or a separate software component) for LB control.

Embodiments of the invention may be employed in a 3GPP network of any generation (3G, 4G, 5G,...) where MLB is employed. They may be employed also in other networks with load balancing between base stations like

CDMA, EDGE, UMTS, LTE, LTE-A, WiFi networks, etc. A cell device may be a base station of the corresponding technology, such as a NodeB or eNodeB, or a part thereof serving a cell. It may also be a terminal which acts as a cell device for other terminals. A terminal (device) or a user equipment may
5 be a mobile phone, a smart phone, a PDA, a laptop or any other terminal which may be attached to the respective network.

One piece of information may be transmitted in one or plural messages from one entity to another entity. Each of these messages may comprise
10 further (different) pieces of information.

Names of network elements, protocols, and methods are based on current standards. In other versions or other technologies, the names of these network elements and/or protocols and/or methods may be different, as
15 long as they provide a corresponding functionality.

If not otherwise stated or otherwise made clear from the context, the statement that two entities are different means that they perform different functions. It does not necessarily mean that they are based on different
20 hardware. That is, each of the entities described in the present description may be based on a different hardware, or some or all of the entities may be based on the same hardware. It does not necessarily mean that they are based on different software. That is, each of the entities described in the present description may be based on a different software, or some or all of
25 the entities may be based on the same software.

According to the above description, it should thus be apparent that exemplary embodiments of the present invention provide, for example a cell device such as a base station (e.g. NodeB, eNodeB), or a component
30 thereof, an apparatus embodying the same, a method for controlling and/or operating the same, and computer program(s) controlling and/or operating the same as well as mediums carrying such computer program(s) and forming computer program product(s). According to the above description,

it should thus be apparent that exemplary embodiments of the present invention provide, for example a control device such as an OAM center or a NMS, or a component thereof, an apparatus embodying the same, a method for controlling and/or operating the same, and computer program(s) controlling and/or operating the same as well as mediums carrying such computer program(s) and forming computer program product(s).

Implementations of any of the above described blocks, apparatuses, systems, techniques or methods include, as non limiting examples, implementations as hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

It is to be understood that what is described above is what is presently considered the preferred embodiments of the present invention. However, it should be noted that the description of the preferred embodiments is given by way of example only and that various modifications may be made without departing from the scope of the invention as defined by the appended claims.

20

Claims

1. Apparatus, comprising
counting means adapted to count, in at least one counter, a number
5 of events of at least one kind caused by load-balancing, wherein the load-
balancing balances a load between the apparatus and a cell device different
from the apparatus;
providing means adapted to provide the at least one counter to a
management device.
- 10 2. The apparatus according to claim 1, wherein, for each of the at least one
kinds of events, the number of events is counted in a respective one of the
at least one counters.
- 15 3. The apparatus according to any of claims 1 and 2, wherein the at least
one kinds of events comprise at least one of
- a mobility change request caused by the load balancing;
 - a mobility change failure, wherein the corresponding mobility change
request is caused by the load balancing;
 - 20 • a mobility change acknowledge, wherein the corresponding mobility
change request is caused by the load balancing;
 - an attempted handover preparation caused by the load balancing;
 - a rejected handover preparation, wherein the corresponding
handover preparation is caused by the load balancing;
 - 25 • a successful handover preparation, wherein the corresponding
handover preparation is caused by the load balancing; and
 - a failed handover, wherein the corresponding handover preparation is
caused by the load balancing.
- 30 4. Apparatus, comprising
measuring means adapted to measure a parameter related to user
experience at a time when the user experience is potentially affected by
load-balancing, wherein the load-balancing balances a load between the
apparatus and a cell device different from the apparatus;

providing means adapted to provide a result of the measuring to a management device.

5 5. The apparatus according to claim 4, wherein the parameter is at least one of an average throughput of users served by the apparatus and a throughput of a fraction of the users served by the apparatus.

10 6. The apparatus according to any of claims 4 and 5, wherein the measuring means is adapted to measure the parameter at a time when at least one of the following conditions is fulfilled:

- the load is higher than a threshold relevant for the load balancing; and
- the time passed after a handover parameter change determining a probability of a handover is performed due to the load balancing is less than a maximum time.

20 7. Base station, comprising an apparatus according to any of claims 1 to 6, wherein the load balancing is adapted to balance the load caused by at least one user served by the base station between the base station and the cell device.

8. The base station according to claim 7, belonging to a third generation partnership project standard.

25 9. Apparatus, comprising

evaluating means adapted to evaluate at least one of a counter received from a first cell device and a measurement result received from the first cell device, wherein the counter counts a number of events of at least one kind caused by load-balancing, the measurement result is related to user experience at a time when the user experience is potentially affected by the load-balancing, and the load-balancing balances a load between the first cell device and a second cell device different from the first cell device;

command generating means adapted to generate a command based on the evaluation of the at least one of the counter and the measurement result, wherein the command is adapted to modify the load-balancing of the first cell device.

5

10. The apparatus according to claim 9, wherein the command comprises at least one of

- adjusting a load threshold of a first cell device for LB action;
- 10 • adjusting a first cell device or second cell device margin, indicating the minimum capacity that has to be reserved apart from the capacity allowed to be used for LB;
- adjusting an eagerness of the first cell device or second cell device for the load-balancing;
- 15 • switching off the load balancing of the first cell device;
- adjusting a cell individual offset of at least one of the first cell device and the second cell device.

20 11. The apparatus according to any of claims 9 and 10, further comprising providing means adapted to provide the command to at least one of the first cell device and the second cell device.

25 12. Operation and maintenance center, comprising an apparatus according to any of claims 9 to 11.

13. Method, comprising
counting, in at least one counter, a number of events of at least one kind caused by load-balancing, wherein the load-balancing balances a load
30 between an apparatus performing the method and a cell device different from the apparatus;
providing the at least one counter to a management device.

14. The method according to claim 13, wherein, for each of the at least one kinds of events, the number of events is counted in a respective one of the at least one counters.

5 15. The method according to any of claims 13 and 14, wherein the at least one kinds of events comprise at least one of

- a mobility change request caused by the load balancing;
- a mobility change failure, wherein the corresponding mobility change request is caused by the load balancing;
- 10 • a mobility change acknowledge, wherein the corresponding mobility change request is caused by the load balancing;
- an attempted handover preparation caused by the load balancing;
- a rejected handover preparation, wherein the corresponding handover preparation is caused by the load balancing;
- 15 • a successful handover preparation, wherein the corresponding handover preparation is caused by the load balancing; and
- a failed handover, wherein the corresponding handover preparation is caused by the load balancing.

20 16. Method, comprising

measuring a parameter related to user experience at a time when the user experience is potentially affected by load-balancing, wherein the load-balancing balances a load between an apparatus performing the method and a cell device different from the apparatus;

25 providing a result of the measuring to a management device.

17. The method according to claim 16, wherein the parameter is at least one of an average throughput of users served by the apparatus and a throughput of a fraction of the users served by the apparatus.

30

18. The method according to any of claims 16 and 17, wherein the measuring is adapted to measure the parameter at a time when at least one of the following conditions is fulfilled:

- the load is higher than a threshold relevant for the load balancing; and
- the time passed after a handover parameter change determining a probability of a handover is performed due to the load balancing is less than a maximum time.

19. Method, comprising

evaluating at least one of a counter received from a first cell device and a measurement result received from the first cell device, wherein the counter counts a number of events of at least one kind caused by load-balancing, the measurement result is related to user experience at a time when the user experience is potentially affected by the load-balancing, and the load-balancing balances a load between the first cell device and a second cell device different from the first cell device;

generating a command based on the evaluation of the at least one of the counter and the measurement result, wherein the command is adapted to modify the load-balancing of the first cell device.

20. The method according to claim 19, wherein the command comprises at least one of

- adjusting a load threshold of a first cell device for LB action;
- adjusting a first cell device or second cell device margin, indicating the minimum capacity that has to be reserved apart from the capacity allowed to be used for LB;
- adjusting an eagerness of the first cell device or second cell device for the load-balancing;
- switching off the load balancing of the first cell device;
- adjusting a cell individual offset of at least one of the first cell device and the second cell device.

21. The method according to any of claims 19 and 20, further comprising providing the command to at least one of the first cell device and the second cell device.

22. A computer program product comprising a set of instructions which, when executed on an apparatus, is configured to cause the apparatus to carry out the method according to any one of claims 13 to 21.

- 5 23. The computer program product according to claim 22, embodied as a computer readable medium or directly loadable into a computer.
-
-

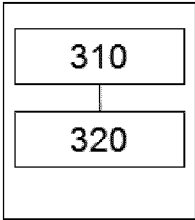


Fig. 7

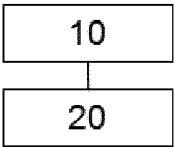


Fig. 1

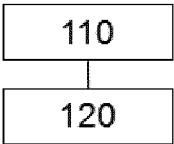


Fig. 3

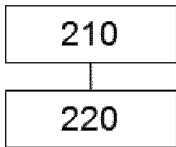


Fig. 5

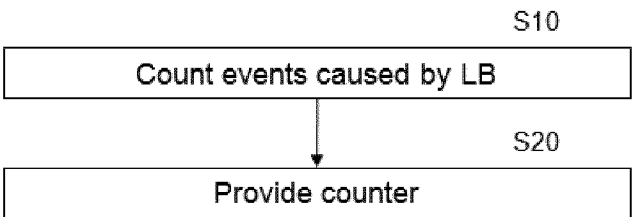


Fig. 2

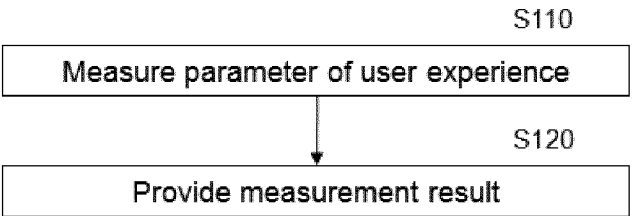


Fig. 4

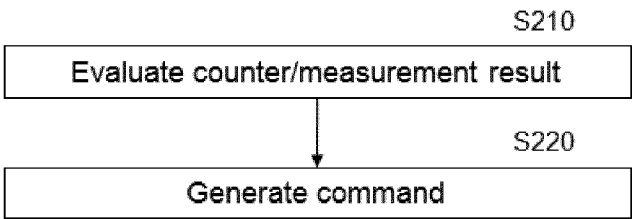


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/065534

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W28/08
ADD. H04W24/02

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HUAWEI ET AL: "Mobility Load Balancing Optimization Solution", 3GPP DRAFT; R3-080361 MOBILITY LOAD BALANCING SOLUTION, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG3, no. Sorrento, Italy; 20080205, 5 February 2008 (2008-02-05), XP050163570, [retrieved on 2008-02-05]	1-4, 6-16, 18-23
Y	SON and RRM; page 1, paragraph 2.2 - page 2; figure 1 Active mode mobility load balancing optimization; page 3, paragraph 4 Idle mode mobility load balancing optimization; -/-	5,17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search

20 March 2014

Date of mailing of the international search report

27/03/2014

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/065534

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	page 2, paragraph 3 - page 3 Conclusion and Proposals; page 4, paragraph 5 -----	
Y	NORTEL ET AL: "Non-GBR QoS indication for Load Balancing SON use case", 3GPP DRAFT; R2-083512 - NON-GBR QOS INDICATION FOR LOAD BALANCING, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. Warsaw, Poland; 20080623, 23 June 2008 (2008-06-23), XP050140888, [retrieved on 2008-06-23]	5,17
A	Using the percentage of UEs experiencing unsatisfactory QoS; page 2, paragraph 2.2 -----	1-4, 6-16, 18-23
A	WO 2011/021593 A1 (NEC CORP [JP]; SERRAVALLE FRANCESCA [GB]; FILIPOVIC MILENA [GB]) 24 February 2011 (2011-02-24) page 7, line 18 - page 9, line 8 -----	1-23
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A	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Telecommunication management; Self-Organizing Networks (SON) Policy Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS) (Release 11)", 3GPP STANDARD; 3GPP TS 32.522, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. SA WG5, no. V11.6.1, 3 July 2013 (2013-07-03), pages 1-57, XP050712017, [retrieved on 2013-07-03] cited in the application page 11, paragraph 4.2.4 - page 15, paragraph 4.3.5 -----	1-23

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2013/065534

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