(12) **UK Patent Application** (19) **GB** (11) **2 458 258** (13) **A**

(43) Date of A Publication   16.09.2009

(54) Abstract Title: **Method of controlling base station loading in a mobile communication system**

(57)   A mobile communications system is described in which base
stations communicate with each other using a Master/Slave
protocol to exchange load balancing information that can be
used to control the handover of mobile devices amongst
neighboring base stations and/or neighboring cells. The
Master base station requests the Slave base station to
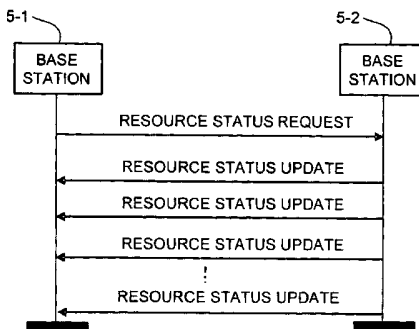provide a load status report to it either at a defined time or
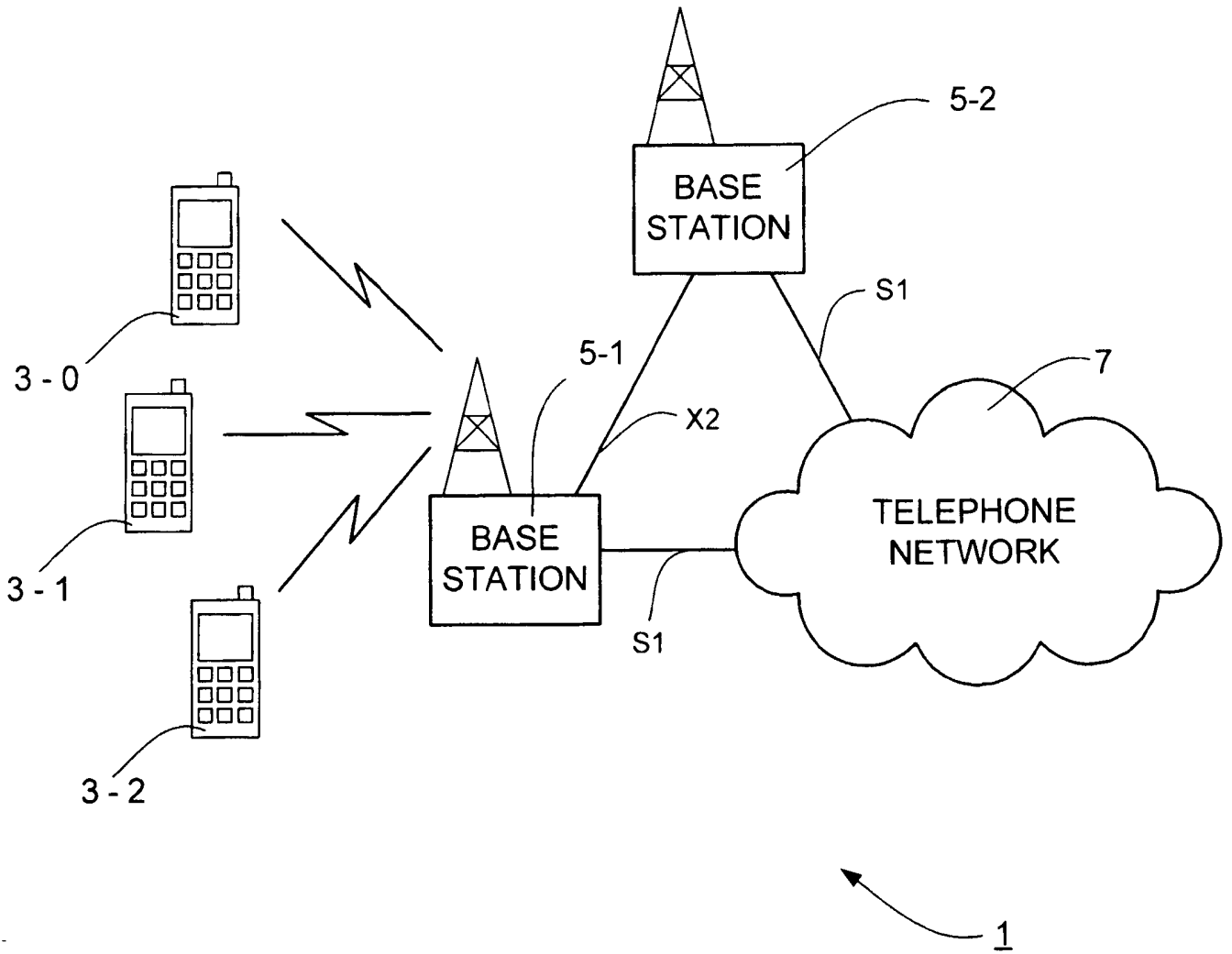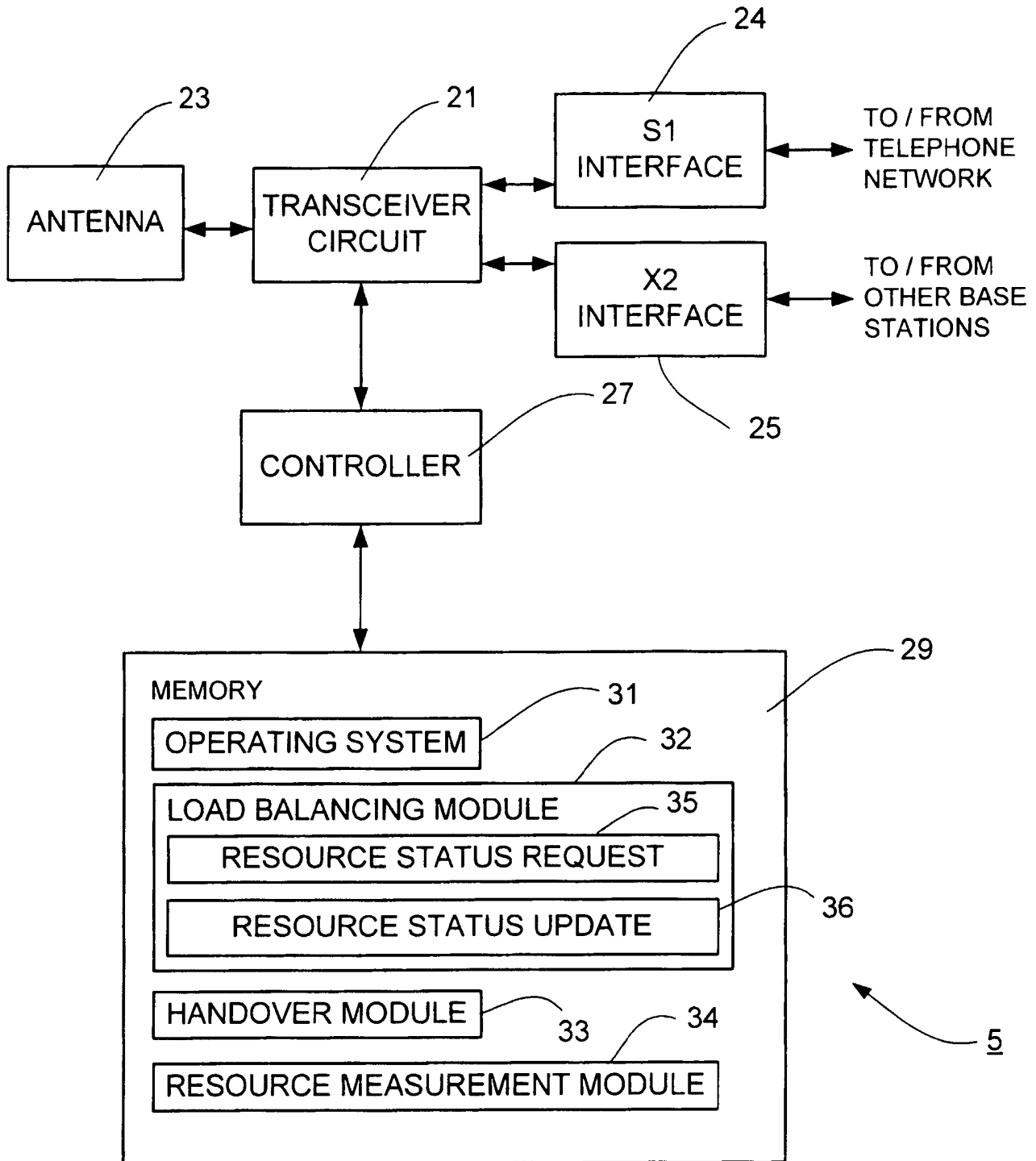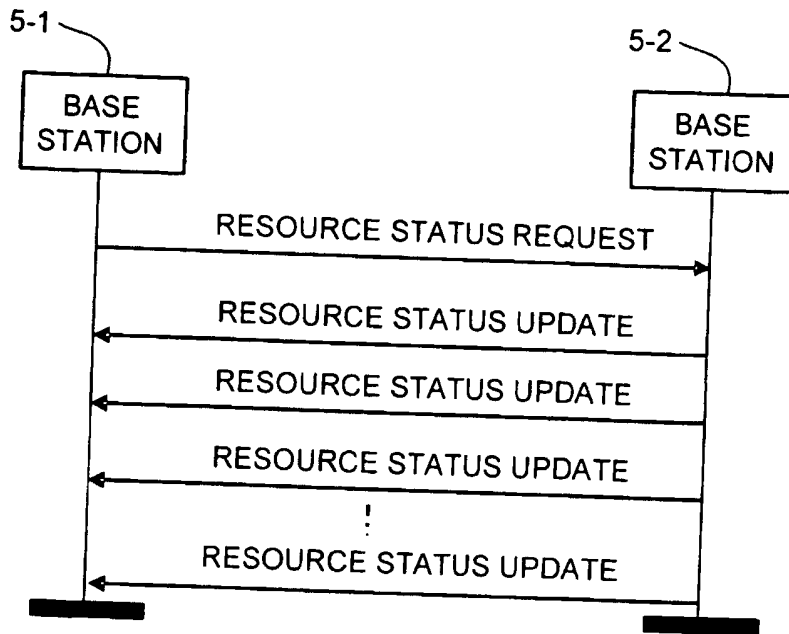periodicity or in response to certain events.
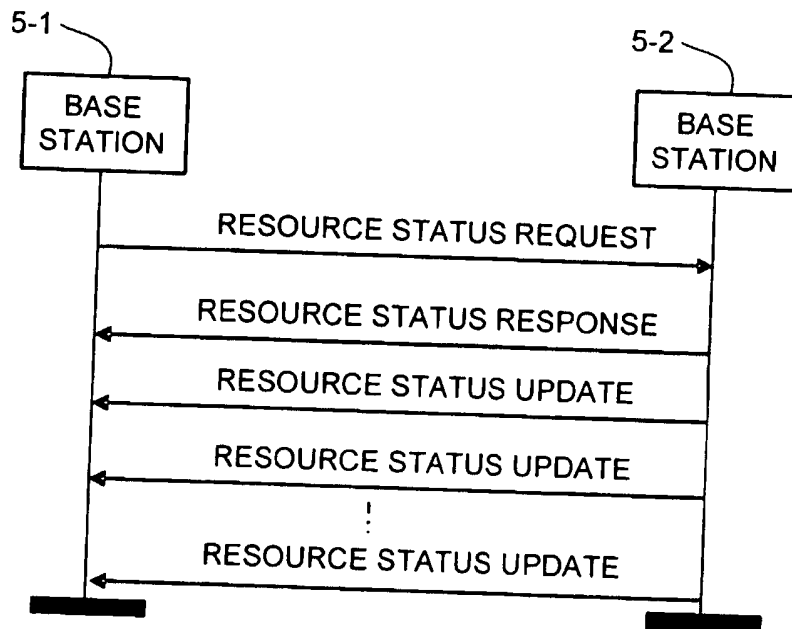
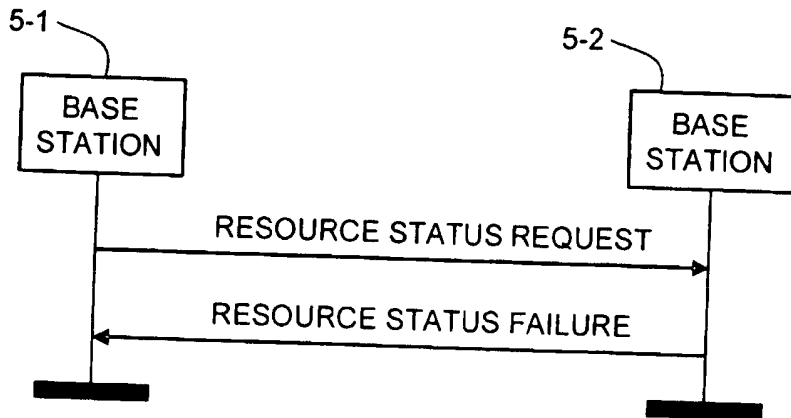FIGURE 3a

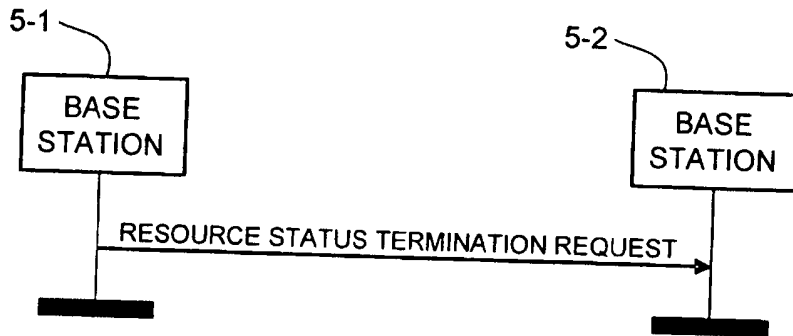FIGURE 1

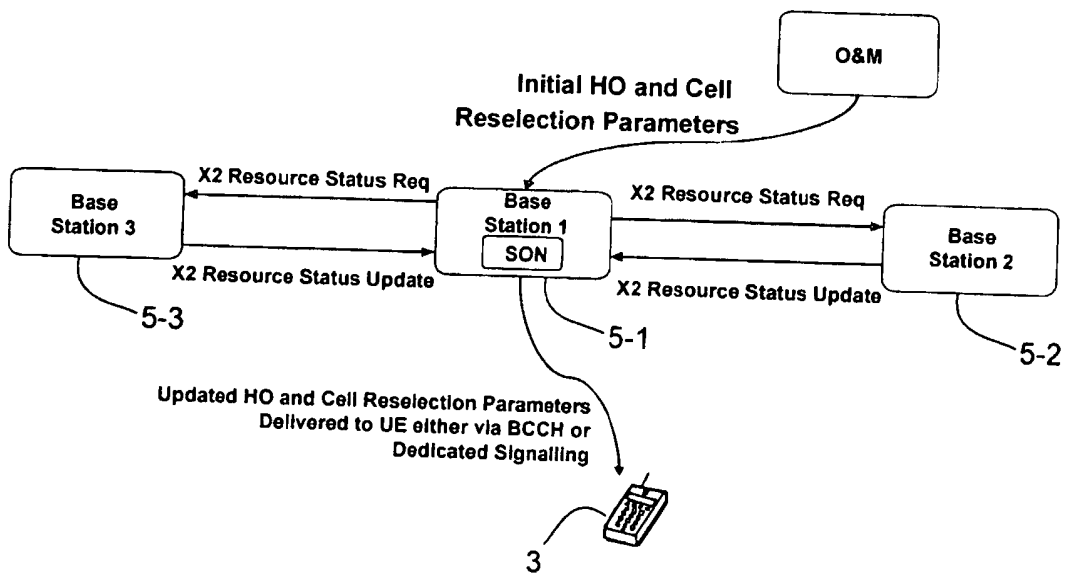FIGURE 2

FIGURE 3a

FIGURE 3b

FIGURE 3c

FIGURE 3d

FIGURE 4

Communications System

The present invention relates to mobile telecommunication networks, particularly but not exclusively networks operating according to the 3GPP standards or equivalents or derivatives thereof. The invention has particular although not exclusive relevance to the Long Term Evolution (LTE) of UTRAN (called Evolved Universal Radio Access Network (E-UTRAN)).

In a mobile telephone network, load balancing is required to share scarcely available radio resources and the processing load between available base stations (referred to as eNBs in E-UTRAN). In order that this load balancing can take place, load measurements are made by the base stations and shared with the neighbouring base stations, so that decisions on load balancing can be taken. In the RAN1#51Bis meeting in Seville 14 to 18 Jan 2008, the load balancing mechanism was discussed. In particular, RAN1 discussed the physical layer measurements needed to support efficient load balancing and agreed that the measurements of the physical resource block usage in the uplink and the downlink are relevant for load balancing. They have proposed the following four different measurements for this purpose:

1)   Physical resource block usage for GBR (real time traffic) on UL

2)   Physical resource block usage for non-real traffic on UL

3)   Physical resource block usage for GBR (real time) traffic on DL

4)   Physical resource block usage for non-real time traffic on DL

All these measurements are defined as a ratio (percentage) of the used Physical Resource Blocks (PRBs) for a type of traffic over the available PRBs in the same direction over a certain time interval, and are measured per cell. Any non-scheduled transmissions and retransmissions should also be counted as used.

Further, RAN 1 believes that it would be sufficient if this control is done at a periodicity in the order of seconds to minutes, or even at a slower rate depending on the expected traffic fluctuation such as for busy hours.

5   However, details of the signalling of this information between the base stations for load balancing have yet to be defined.

Although for efficiency of understanding for those of skill in the art the invention will be described in detail in the context of a 3G system, the principles of the handover
10   procedure can be applied to other systems, e.g. other CDMA or wireless systems in which mobile devices or User Equipment (UE) communicate with one of several other devices (corresponding to eNB) with the corresponding elements of the system changed as required.

15   Embodiments of the present invention aim to provide efficient techniques for signalling these measurements between the base stations.

According to one aspect, the present invention provides a method performed by a EUTRAN base station comprising: sending a request for load balancing
20   measurements to a neighbouring EUTRAN base station; receiving one or more resource status update messages from the neighbouring EUTRAN base station in response to the requested resource status information; and performing load balancing operations in dependence upon the received one or more resource status messages.

25   The base station may also use load balancing measurements for itself and use these also for performing the load balancing operations. These measurements may be measured directly by the base station.

The one or more status update messages may include data identifying the physical resource block usage for real time and/or non-real time traffic on the
30   uplink or the downlink.

The requesting base station may request the other base station to provide the status updates at a specific time, periodically or in response to one or more

specific events. The event may be, for example, when usage of a resource by the neighbouring base station exceeds a defined threshold and/or when the uplink interference level exceeds a defined threshold.

The request preferably defines a time period over which the load measurements are obtained. Additionally, where the neighbouring base station has a plurality of associated cells, the request may identify a subset of those cells for which the measurements are requested.

The base station can control handover of one or more associated mobile communication devices to another cell or base station in dependence upon the one or more received resource status update messages. It can do this, for example, by dynamically controlling Handover and Cell re-selection parameters in dependence upon the one or more received resource status update messages.

This aspect of the invention also provides a method performed by a EUTRAN base station comprising: receiving a request for resource status information from a neighbouring EUTRAN base station; generating one or more resource status update messages including one or more load balancing measurements; and sending the generated one or more resource status update messages to the requesting base station.

The invention also provides corresponding base stations for performing the above methods.

The invention provides, for all methods disclosed, corresponding computer programs or computer program products for execution on corresponding equipment, the equipment itself (user equipment, nodes or components thereof) and methods of updating the equipment.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 schematically illustrates a mobile telecommunication system of a type to which the embodiment is applicable;

Figure 2 schematically illustrates a base station forming part of the system shown in Figure 1;

Figure 3a schematically illustrates a signalling method for signalling the load balancing measurements between two base stations;

5   Figure 3b schematically illustrates another signalling method for signalling the load balancing measurements between two base stations; and

Figure 3c schematically illustrates a situation where a signalling failure occurs between two base stations;

Figure 3d schematically illustrates one way in which termination may be signalled
10   between two base stations; and

Figure 4 illustrates the way in which load information within a base station can be used to dynamically control Handover and cell selection parameters.

Overview

15   Figure 1 schematically illustrates a mobile (cellular) telecommunication system 1 in which users of mobile telephones (MT) 3-0, 3-1, and 3-2 can communicate with other users (not shown) via one of the base stations 5-1 or 5-2 and a telephone network 7. A number of uplink and downlink communications resources (sub-carriers, time slots etc) are available for the wireless link between the mobile
20   telephones 3 and the base stations 5. In this embodiment, the base stations 5 allocate downlink resources to each mobile telephone 3 depending on the amount of data to be sent to the mobile telephone 3. Similarly, the base stations 5 allocate uplink resources to each mobile telephone 3 depending on the amount and type of data the mobile telephone 3 has to send to the base station 5.

25

Each of the Base stations 5 includes an "S1" interface for interfacing with the core telephone network 7 and an "X2" interface for interfacing with neighbouring base stations 5. Load balancing measurements made by the base stations 5 are sent to the neighbouring base stations 5 over the X2 interface. In this embodiment, the
30   measurement reports are transmitted between the base stations 5 using a Master/Slave signalling mechanism, in which a Master base station 5-1 requests measurement reports from a Slave base station 5-2 in a defined format and periodicity etc, and in which the Slave base station 5-2 responds in the requested manner. Each base station 5 will act as Master when gathering load balancing

4

information from neighbouring base stations 5 and as a Slave when providing its own load balancing information to neighbouring base stations 5. In this way, each base station 5 can obtain the load balancing information it wants, at the periodicity it wants and in the format it wants. This makes interoperability between different makes of base station 5 easier and will significantly reduce unnecessary traffic over the X2 interface.

Base Station

Figure 2 is a block diagram illustrating the main components of each of the base stations 5 used in this embodiment. As shown, each base station 5 includes a transceiver circuit 21 which is operable to transmit signals to and to receive signals from i) the mobile telephones 3 via one or more antennae 23; ii) the telephone network 7 via the S1 interface 24; and iii) other base stations 5 via the X2 interface 25. A controller 27 controls the operation of the transceiver circuit 21 in accordance with software stored in memory 29. The software includes, among other things, an operating system 31, a load balancing module 32, a handover module 33 and a resource measurement module 34. The load balancing module 32 has a resource status request module 35 for issuing status requests to other base stations 5 requesting information on the load in the other base station 5; and a resource status update module 36 for providing load information to other base stations 5 when requested to do so. The Handover module 33 is responsible for controlling handover of mobile telephones 3 to or from the base station 5. The Resource measurement module 34 is responsible for obtaining the load information discussed above (which is sent to other base stations 5 by the resource status update module 36), ie:

1)   Physical resource block usage for GBR (real time traffic) on UL;

2)   Physical resource block usage for non-real traffic on UL;

3)   Physical resource block usage for GBR (real time) traffic on DL; and

4)   Physical resource block usage for non-real time traffic on DL.

In the above description, the base station 5 is described for ease of understanding as having a number of discrete modules (such as the load balancing module,

handover module, resource measurement module etc). Whilst these modules may be provided in this way for certain applications, for example where an existing system has been modified to implement the invention, in other applications, for example in systems designed with the inventive features in mind from the outset,

5   these modules may be built into the overall operating system or code and so these modules may not be discernible as discrete entities.

Load Balancing – Signalling Mechanism

In this embodiment, the base stations 5 selectively provide load information when

10   requested by their neighbours. A base station 5-1 may request a neighbouring base station 5-2 to send load information in the format it likes (based on the Radio Resource Management (RRM) algorithm that is implemented by the requesting base station 5-1). For example the requesting base station 5-1 may indicate in a *Resource Status Request* (generated by the resource status request module 35)

15   to the neighbouring base stations 5-2 if it needs load information to be reported just once, or periodically, or in an event driven fashion whenever any of one or more events occurs. The base station 5-2 that receives the request then responds at the appropriate time/event in a *Resource Status Update* (generated by the Resource status update module 36). In this way, the requesting base station 5-1

20   is acting as a "Master" and the responding base station 5-2 is acting as a "Slave". The scheduling used is illustrated in Figure 3a.

Details of Resource Status Request Message

The Master base station 5-1 will send a *Resource Status Request* to the Slave

25   base station 5-2 requesting it to report its physical resource block usage information. The *Resource Status Request* will include a Reporting Characteristics Information Element (IE), which indicates whether this reporting shall be once, or periodically, or event driven, in which case the event is also specified. If the Reporting Characteristics IE is not set, then, in this embodiment, the Slave base

30   station 5-2 shall send the *Resource Status Update* only once.

In this embodiment, a separate message to stop the *Resource Status Update* is not needed. Instead, the Master base station 5-1 sends the same request message, with the Reporting Characteristics IE value set to zero. The Slave base

station 5-2 shall interpret this message as a request to stop the *Resource Status Update* reporting, which it will process immediately and acknowledge with a similar value of zero in a corresponding *Resource Status Update* message.

5   Where the *Resource Status Request* message requests event triggered reports for multiple events, it may also specify thresholds for those events. For example, the Master base station 5-1 may request a Slave base station 5-2 to report to it whenever its Total Physical Resource Block usage is above 95%, indicating a near congestion situation. Similarly, the Slave may be asked to report if the downlink
10   transmitted power exceeds a certain threshold value.

In this embodiment, the *Resource Status Request* message generated by the Master base station 5-1 may include the "Averaging Time" to specify the measurement interval for producing the information requested by the Master base
15   station 5-1. If this value is not specified, then the Slave base station 5-2 will apply a default value.

In this embodiment, the *Resource Status Request* message generated by the Master base station 5-1 may include a Reporting Time to specify a periodic
20   reporting based on the Master bases station's internal RRM algorithm. If this value is not specified, the Slave base station 5-2 may apply a default value.

As will be understood by those skilled in the art, each base station 5 may control several different cells and, in this embodiment, the *Resource Status Request*
25   message generated by the Master base station 5-1 may also include the cell Id's of the cells for which it is interested in receiving the resource load information. If this value is not specified, the slave base station 5-2 will report the resource load status of all its cells.

30   **Details of Resource Status Update Message**

In this embodiment, the *Resource Status Update* message shall include a Reporting Characteristics IE to indicate the reason for the report. A couple of values in the Reporting Characteristics IE could be reserved to indicate congestion in the cell either in the UL or in the DL direction in terms of Physical layer

7

resources or any other type of processing resources. A *Resource Status Update* message with a congestion indication can also be autonomously sent by Slave base stations 5-2 to the neighbouring Master base stations 5-1 who have requested Resource status updates whenever congestion is detected. Further, the

5 Slave base stations 5-2 can autonomously send the *Resource Status Update* message when the congestion is resolved. A *Resource Status Update* message can also be autonomously sent by a Slave base station 5-2 to the neighbouring Master base stations 5-1 who have requested *Resource status updates* whenever UL interference exceeds a particular threshold in its own cell, thus incorporating

10 the existing procedure "Load Information" in it.

The *Resource Status Update* message will also include the relevant measurements requested by the Master base station 5-1:

15 1)   Averaged Physical resource block usage for real time traffic on UL based on the Averaging/ Reporting Time specified by the Master base station 5-1;

2)   Averaged Physical resource block usage for non-real traffic on UL based on the Averaging/ Reporting Time specified by the Master base station

20 5-1;

3)   Averaged Physical resource block usage for real time traffic on DL based on the Averaging/ Reporting Time specified by the Master base station 5-1; and

4)   Averaged Physical resource block usage for non-real time traffic on

25 DL based on the Averaging/ Reporting Time specified by the Master base station 5-1.

As mentioned above, in general, each base station 5 will have both the Master (in Asking Resource Status Information) and Slave (Providing Resource Status

30 Reports) roles. However, a base station 5 may not implement a load balancing algorithm and in this case shall act only as a Slave in providing the Resource Status Reports to neighbouring base stations 5, which may be considered to be mandatory.

In an alternative embodiment, there could be a more sophisticated procedure where the Slave base station 5-2 responds to a *Resource Status Request* such as in the manner illustrated in Figure 3b, where there is a successful initiation and in Figure 3c, where the initiation failed. The initial failure may be because the Slave
5   base station 5-2 does not not support the requested measurements. However, if it is mandatory for each Base station 5 to provide *Resource Status update* messages to other neighbouring base stations 5, then such a response/failure message may not be needed. In addition, a positive stop or termination message may also be sent to terminate the signalling between the Master and Slave base
10   stations 5.

As those skilled in the art will appreciate, with the signalling discussed above, load reporting can be performed based on the Reporting period specified by the Master base station 5-1, thereby allowing the Master base station 5-1 to effectively utilize
15   the received resource status information even in a multi vendor scenario, where implementation specific algorithms are run in different base stations 5. Furthermore, redundant signalling over the X2 interface 25 can be reduced.

Load Information Procedure
20   Presently 3GPP Standard document TS 36.423 defines a Load Information Procedure, the purpose of which is to transfer the uplink Interference Overload Indication between intra-frequency neighboring base stations 5 for interference coordination purposes. Overload Indications are sent when the base station 5 experiences too high interference levels in the UL on some resource blocks due to
25   a mobile telephone 3 at the cell edge using high power to transmit UL data. Base stations 5 that receive this message, should in principle, ask the mobile telephone 3 to reduce the UL transmit power that is causing the interference.

A base station 5 initiates the procedure by sending a *Load Information* message to
30   intra-frequency neighbouring base stations 5. The Load Information Procedure is used to send interference overload indications when the base station 5 experiences too high interference levels on some resource blocks.

The *Resource Status update* procedure described above can incorporate this

Load Information Procedure if the *Resource Status Update* messages can be autonomously sent by the Slave base stations 5-2 to the neighbouring Master base stations 5-1 that have requested the *Resource status update* and have intra frequency cells whenever the UL interference exceeds a particular threshold in its
5 own cell. Such a merged procedure could be called either a *Resource Status Update* or *Load Information Procedure*, whichever is more appropriate.

Associated SON Functionality

The load information obtained by the base station 5 in the above manner can be
10 utilized to dynamically control Handover and Cell (Re-)Selection parameters of a cell controlled by the base station 5, through an internal SON entity (which is a self organizing Network that provides RRM functionality within the base station 5). In other words, the load information obtained can be used to control how the base station 5 selects which cell a mobile telephone 5 should be passed to as the
15 telephone 3 roams within the network's coverage area. This is illustrated in Figure 4.

Cell re-selection parameters that could be updated include:
1. Inter-frequency reselection priorities
2. layer specific offset
20 (How to apply it to the Intra frequency case is FFS (for further study) as it is based on ranking of cells.)

Hand Over parameters that can be configured include:
1. Hysteresis
25 2. Time to trigger
3. etc.

Modifications and Alternatives

A detailed embodiment has been described above. As those skilled in the art will
30 appreciate, a number of modifications and alternatives can be made to the above embodiment whilst still benefiting from the inventions embodied therein.

In the above embodiment, a mobile telephone based telecommunications system was described. As those skilled in the art will appreciate, the signalling and handover techniques described in the present application can be employed in other communications system. Other communications nodes or devices may

5   include user devices such as, for example, personal digital assistants, laptop computers, web browsers, etc.

In the above embodiments, a number of software modules were described. As those skilled will appreciate, the software modules may be provided in compiled or un-compiled form and may be supplied to the base station or to the mobile

10   telephone as a signal over a computer network, or on a recording medium. Further, the functionality performed by part or all of this software may be performed using one or more dedicated hardware circuits. However, the use of software modules is preferred as it facilitates the updating of base station 5 and the mobile telephones 3 in order to update their functionalities.

15   Various other modifications will be apparent to those skilled in the art and will not be described in further detail here.

Glossary of 3GPP terms

LTE – Long Term Evolution (of UTRAN)

20   eNodeB – E-UTRAN Node B

UE – User Equipment – mobile communication device

DL – downlink – link from base to mobile

UL – uplink – link from mobile to base

MME – Mobility Management Entity

25   UPE- User Plane Entity

HO – Handover

RLC – Radio Link Control

RRC – Radio Resource Control

RRM – Radio Resource Management

SAE – System Architecture Evolution

C-RNTI – Cell-Radio Network Temporary Identifier

5   SIB – System Information Block

U-plane - User Plane

X2 Interface – Interface between two eNodeB

S1 Interface – Interface between eNodeB and MME

TA – Tracking Area

10   EPC – Evolved Packet Core

AS – Access Stratum

RNL – Radio Network Layer

TNL – Transport Network Layer

RACH – Random Access Channel

15   MU MIMO – Multi-User Multi Input Multi Output

DMRS – Demodulation Reference Signal Format

MCS – Modulation and Coding Scheme

The following is a detailed description of the way in which the present inventions
20   may be implemented in the currently proposed 3GPP LTE standard. Whilst
various features are described as being essential or necessary, this may only be
the case for the proposed 3GPP LTE standard, for example due to other
requirements imposed by the standard. These statements should not, therefore,
be construed as limiting the present invention in any way.

Introduction

In the RAN1#51Bis meeting, the load balancing mechanism was discussed. A reply LS in [1] has been sent to RAN 2 and RAN 3 to inform the outcomes of the agreements in RAN 1. In this contribution we provide further details about the signalling involved in order to have the achieve the load balancing.

Measurement Definitions

RAN1 has discussed the physical layer measurements needed to support efficient load balancing and have agreed that the measurements of the physical resource block usage in uplink and downlink are relevant for this use case. They have proposed 4 different measurements listed below for this purpose

> ➤ **M1   Physical resource block usage for GBR (real time traffic) on UL**

> ➤ **M2   Physical resource block usage for non-real traffic on UL**

> ➤ **M3   Physical resource block usage for GBR (real time) traffic on DL**

> ➤ **M4   Physical resource block usage for non-real time traffic on DL**

All these measurements are defined as a ratio (percentage) of the used PRBs for a type of traffic over the available PRBs in the same direction over a certain time interval, and are measured per cell. Any non-scheduled transmissions and retransmissions should also be counted as used.

Further, RAN 1 believes that it is would be sufficient if this control is done at a periodicity in the order of seconds to minutes, or even at a slower rate depending on the expected traffic fluctuation such as for busy hours.

Details of the signalling for load balancing mechanism is yet to be defined. In the next section we explore different options of how the measured quantities are signalled over X2 interface and what parameters Handover and reselection parameters could be re-configured.

Signalling Over X2

4.1. All eNB informs measured load information to other neighbors

This is the simplest scenario where each eNBs informs measured load information
5   to all the neighbors to which they have an established X2 connection by sending
for example : *Resource Status Update* Message periodically. Alternatively, this
information may be piggy-backed on dedicated messages.
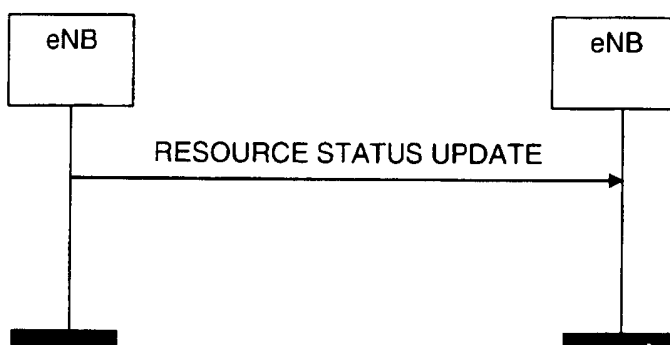
10   Figure1. Simple Resource Status Update procedure

As different vendors eNBs may implement different algorithms which would
process the *Resource Status Update* Report at different intervals, using a one
fixed interval for reporting may result in reports being sent too frequently and the
eNB just discarding large number of these reports. For example if the Load
15   balancing algorithm operates every 5 seconds, a *Resource Status Update*
reporting interval is fixed at say 1 sec then 4 out of 5 reports may be discarded.

4.2.   eNB requests load information selectively from neighbor eNBs

An eNB may request the neighbouring eNB to send load information in the fashion
it likes (based on the implemented RRM algorithm) For example the requesting
20   eNB may indicate in the *Resource Status Request* to the neighbouring eNB if it
needs Load information to be reported just once, or periodically, or in an event
driven fashion whenever any of the corresponding multiple event occurs.
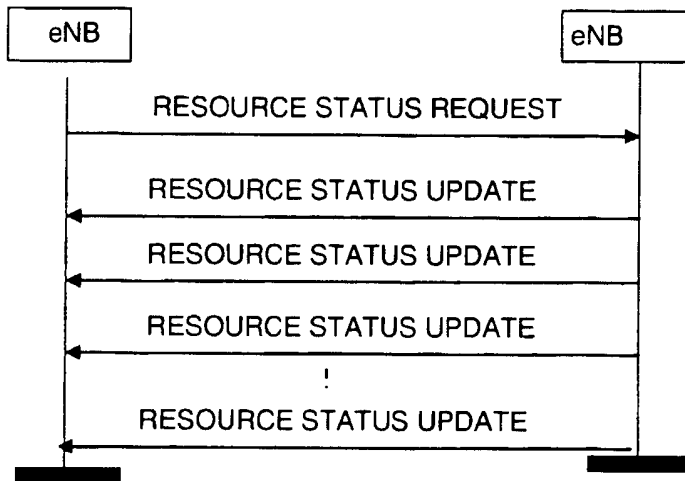
5   Figure 2. Master Slave based Resource Status Update Procedure

We call this as a Master Slave configuration where the requesting eNB is the master and can request the information in the format it desires.

Details of Resource Status Request Message

10

> Master eNB1 sends an *Resource Status Request* to Slave eNB2 requesting it to indicate the physical resource block usage either once, or periodically, or event driven manner.

> Reporting Characteristics IE indicates whether reporting shall be once, or
15   periodically, or event driven, in which case the event is specified. If the reporting characteristics IE is not set, then the *Resource Status Update* SHALL be sent only once by the slave eNB.

> Note that a separate message to Stop the *Resource Status Update* need not be specified. The same request message, with Reporting
20   Characteristics value set to 0, shall be interpreted as a request to stop the *Resource Status Update* reporting, which shall be processed by the

15

receiver immediately and acknowledged with a similar value of 0 in the corresponding *Resource Status Update* message

> In the *Resource Status Request* message, the reporting characteristics IE would allow the Master eNB to request either periodic or event triggered reports for multiple events and the possibility of providing the thresholds for these events.

> In the *Resource Status Request* message, the Averaging Time could be included by the Master eNB to specify a measurement interval for producing the information requested by Master eNB. If this value is not specified, the slave eNB shall apply a default value

> In the *Resource Status Request* message, the Reporting Time could be included by the Master eNB to specify a reporting based on its internal RRM algorithm. If this value is not specified, the slave eNB shall apply a default value

> In the *Resource Status Request* message, Master eNB could include the cell Id's of the cells for which it is interested in receiving the resource information. If this value is not specified, the slave eNB shall report the resource status of all the cells.

Details of Resource Status Update Message

> *Resource Status Update* message shall also including Reporting Characteristics IE to indicate the reason for this report.

> In Reporting Characteristics IE,-couple of the values could reserved to indicate congestion in the cell either in UL or in DL direction in terms of Physical layer resources or any other type of processing resources. Resource Status Update Report with congestion indication can be autonomously sent by slave eNB to the neighbouring Master eNBs who have requested Resource status update whenever a congestion is detected. Further, slave eNB can autonomously send the Resource Status Update Report when the congestion is resolved.Resource Status Update Report could be autonomously sent by slave eNB to the neighbouring

Master eNBs who have requested Resource status update whenever UL interference exceeds a particular thereshold in its own cell. Thus incorporating the existing procedure Load Information in it.

5

➢ Averaged Physical resource block usage for GBR (real time traffic) on UL based on the Averaging/ Reporting Time specified by Master eNB

➢ Averaged Physical resource block usage for non-real traffic on UL based on the Averaging/ Reporting Time specified by Master eNB

➢ Averaged Physical resource block usage for GBR (real time) traffic on DL based on the Averaging/ Reporting Time specified by Master eNB

10

➢ Averaged Physical resource block usage for non-real time traffic on DL based on the Averaging/ Reporting Time specified by Master eNB

➢ ....

It should be noted that in general each eNB is having both the Master (in Asking Resource Status Information) and Slave (Providing Resource Status Reports) roles. However, an eNB may not implement a load balancing algorithm and in this case shall act only as a slave in providing the Resource Status report to neighbouring eNB which may be considered to be mandatory.

15

Alternatively we could have more sophisticated procedure similar to Common Measurement Procedure defined in UMTS over Iur interface where there is a response to a Resource Status Request such as Resource Status Response as shown in Figure 3 Compared to option 2 it provides the eNB to reject the Resource Status Request in case it does not supported a requested measurements.
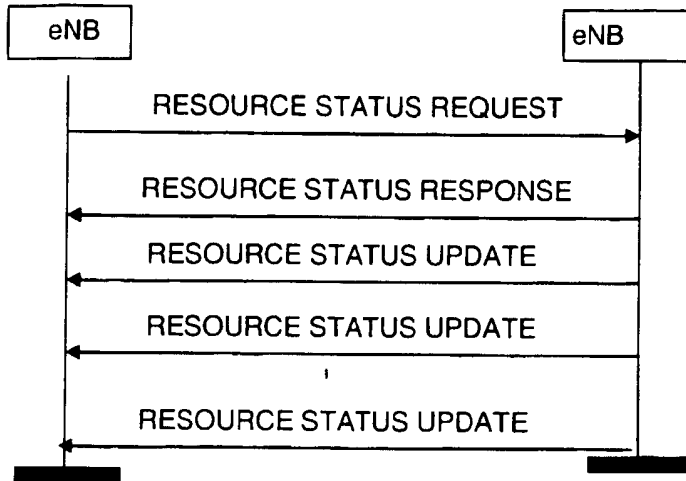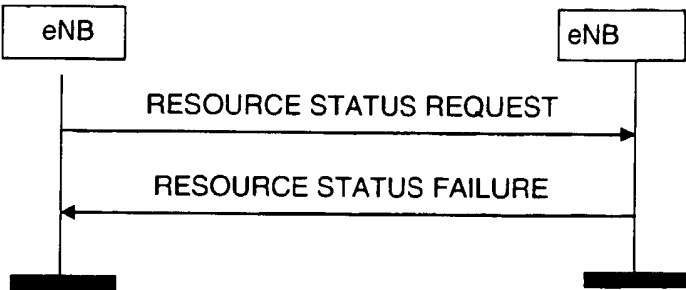
20

Figure 3a Common Measurement like Resource Status Update Procedure (Successful Initiation)

Figure 3b Common Measurement like Resource Status Update Procedure (Unsuccessful Initiation)
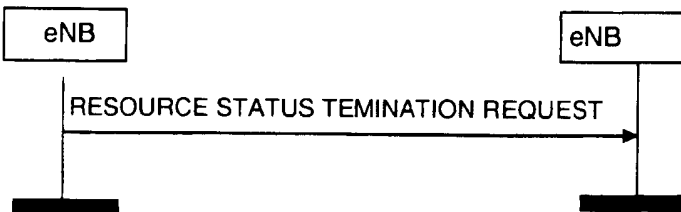
Figure 3c Common Measurement like Resource Status Update Procedure (Termination)

Such a procedure will require 5 messages as compared to Master Slave Configuration proposed in Figure 2. However, if it is mandatory for each eNB to provide Resource Status update to other neighbouring eNB then such a response/ failure message may not be needed.

Such an options would allow reporting of the load information based on the

18

Reporting period specified by the Master eNB so that it could effectively utilize resource status information in multi vendor scenario allowing the implementation specific algorithms perform efficiently. Furthermore, the redundant signalling over X2 could be reduced.

5 Relation to Load information Procedure

Presently Load information Procedure is defined in [3]. The purpose of the Load indication procedure is to transfer the uplink Interference Overload Indication between intra-frequency neighboring eNodeBs for interference coordination purpose.

10
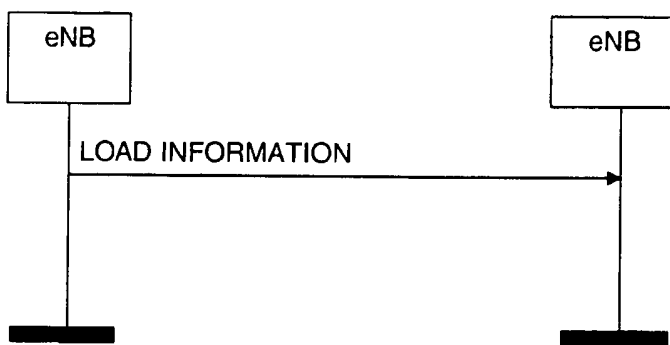
An eNodeB initiates the procedure by sending LOAD INFORMATION message to intra-frequency neighbouring eNodeBs. The LOAD INFORMATION message can carry interference overload indication. The Load indication procedure shall be 15 used to send interference overload indication when the eNB experiences too high interference level on some resource blocks.

The proposed Resource Status update procedure can incorporate the above procedure if the Resource Status Update Report could be autonomously sent by slave eNB to the neighbouring Master eNBs who have requested Resource status 20 update and have intra frequency cells whenever UL interference exceeds a particular threshold in its own cell. Hence for the sake of simplicity we propose to merge these to procedures together. We could call the merged procedure either as Resource Status Update or Load Information Procedure, whichever seems more appropriate.

25

Associated SON functionality

The Load Information within the eNB can be utilized to dynamically control Handover and Cell (Re-) Selection parameters of the cell controlled by eNB through internal SON entity. The mechanism is shown in Figure 4.

5

10

15
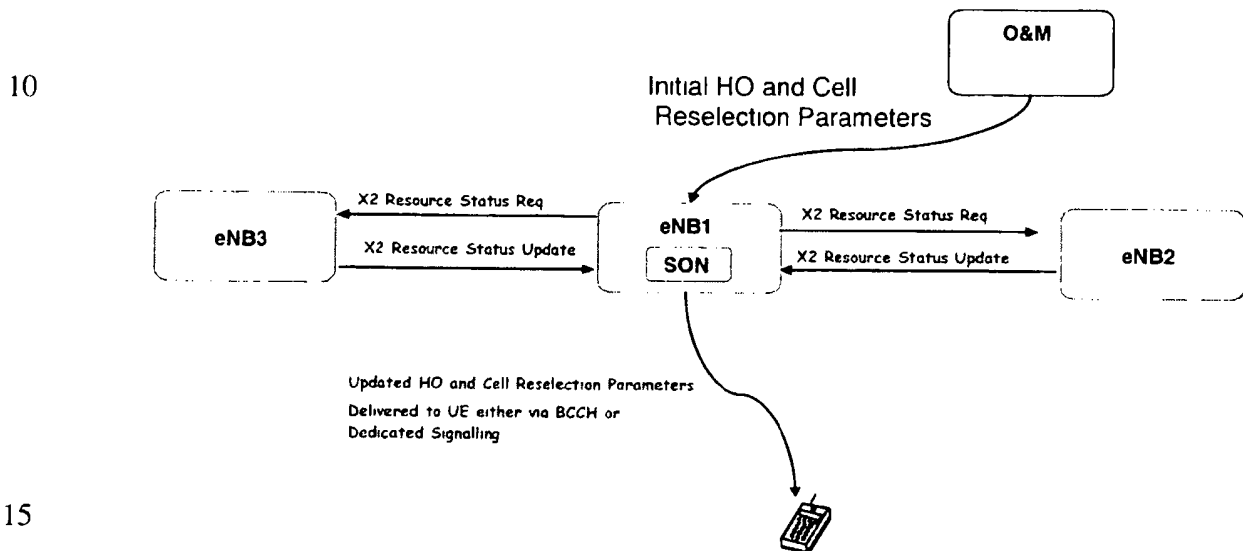
Cell re-selection parameters that could be updated are. [How to apply it to Intra frequency case is FFS as it is based in ranking of cells.]

20   3. Inter-frequency reselection priorities

    4. layer specific offset

Hand Over parameters that can be configured are

    1. Hysteresis

25   2. Time to trigger

3. etc.

Conclusions

In this contribution we discuss various option for exchanging information about the Resource Status between eNBs. We believe that Master /Slave kind configuration
5   would be very flexible in providing the resource status reports to the implementation specific RRM algorithms in a multi -vendor scenario and should be adopted. We urge RAN 3 to agree on the proposed Master/Slave kind of reporting option and the associated text proposal in [4] for X2AP specs.

Further we also discuss the handover and Cell Reselection parameters that could
10 be optimized in the associated SON functionality and if agreeable some details could be captured in Stage 2 TS.

References

[1]   R1-080601, Reply LS on Load balancing, RAN 1

[2]   25.423 3GPP Specification for RNSAP

15 [3]   36.423 3GPP Specifications for X2AP

[4]   R3-08XXXX Text procedure for Resource Status Update Procedure.

Claims:

1.   A method performed by a EUTRAN base station comprising:

5   generating a request for resource status information;

sending the generated request to a neighbouring EUTRAN base station;

receiving one or more resource status update messages from the neighbouring EUTRAN base station in response to the requested resource status information; and

10   performing load balancing operations in dependence upon the received one or more resource status messages.

2.   A method according to claim 1, comprising obtaining load balancing measurements for resources associated with the requesting base station and 15   wherein said performing step performs said load balancing operations in dependence upon the obtained load balancing measurements and the received one or more resource status messages.

3.   A method according to claim 2, wherein said obtaining step obtains 20   said measurements by making the measurements.

4.   A method according to any of claims 1 to 3, wherein said one or more status update messages include data identifying the physical resource block usage for real time and/or non-real time traffic on the uplink.

25

5.   A method according to any of claims 1 to 3, wherein said one or more status update messages include data identifying the physical resource block usage for real time and/or non-real time traffic on the downlink.

5   6.   A method according to any of claims 1 to 5, wherein said generated request is for requesting said resource status information at a defined time.

7.   A method according to any of claims 1 to 5, wherein said generated request is for requesting said resource status information at a defined periodicity.

10

8.   A method according to claim 7, further comprising generating and sending a further request with a reporting time field set at a defined value to stop the neighbouring base station from transmitting further status reports.

15 9.   A method according to any of claims 1 to 5, wherein said generated request is for requesting said resource status information at a defined event.

10.   A method according to claim 9, wherein said generated request is for requesting the neighbouring base station to transmit a resource status report when 20 usage of a resource by the neighbouring base station exceeds a defined threshold.

11.   A method according to claim 9, wherein said generated request is for requesting the neighbouring base station to transmit a resource status report when 25 the uplink interference level exceeds a defined threshold.

12.   A method according to claim 9, 10 or 11, wherein said generated request is for requesting said resource status information at any of a plurality of defined events.

5   13.   A method according to any of claims 1 to 12, wherein said generated message includes data identifying an averaging time specifying a measurement interval for producing the requested information.

14.   A method according to any of claims 1 to 13, wherein said generated
10   request includes data defining a subset of the cells associated with the neighbouring base station, indicating that the requested information is in respect of the cells in the subset and not the cells outside the subset.

15.   A method according to any of claims 1 to 14, wherein said base
15   station is operable to control handover of one or more associated mobile communication devices to another cell or base station in dependence upon the one or more received resource status update messages.

16.   A method according to any of claims 1 to 15, wherein said base
20   station is operable to dynamically control Handover and Cell re-selection parameters in dependence upon the one or more received resource status update messages.

17.   A method according to claim 16, wherein said cell re-selection
25   parameters include Inter-frequency reselection priorities and/or layer specific offset.

18.   A method according to claim 16 or 17, wherein said Handover parameters include hysteresis and/or time to trigger.

19.   A method performed by a EUTRAN base station comprising:

5   receiving a request for resource status information from a neighbouring EUTRAN base station;

obtaining one or more load balancing measurements for resources associated with the base station;

generating one or more resource status update messages including the one
10 or more load balancing measurements; and

sending the generated one or more resource status update messages to the neighbouring EUTRAN base station.

20.   A method according to claim 19, wherein said generating step
15 generates and sends said one or more resource status update messages in accordance with requirements defined by the neighbouring base station in said received request.

21.   A method according to claim 19 or 20, wherein said obtaining step
20 obtains said measurements by making the measurements.

22.   A method according to any of claims 19 to 21, wherein said generated one or more status update messages include data identifying the physical resource block usage for real time and/or non-real time traffic on the uplink.

25

23.   A method according to any of claims 19 to 21, wherein said generated one or more status update messages include data identifying the physical resource block usage for real time and/or non-real time traffic on the downlink.

5   24.   A method according to any of claims 19 to 23, wherein said received request defines a time when the update message should be sent and wherein said sending step sends an update message at the defined time.

25.   A method according to any of claims 19 to 23, wherein said received
10   request defines a periodicity when the update messages should be sent and wherein said sending step sends update messages at the defined periodicity.

26.   A method according to claim 25, further comprising receiving a further request from the same base station, with a reporting time field set at a defined
15   value and comprising the step of stopping the periodic transmission of said status update messages in response thereto.

27.   A method according to any of claims 19 to 23, wherein said received request is for requesting said resource status information at a defined event.

20

28.   A method according to claim 27, wherein said received request is for requesting the base station to send a resource status report when usage of a resource by the base station exceeds a defined threshold.

25   29.   A method according to claim 27, wherein said received request is for requesting the base station to send a resource status report when the uplink interference level exceeds a defined threshold.

30.　　　A method according to claim 27, 28 or 29, wherein said received request is for requesting said resource status information at any of a plurality of defined events.

5

31.　　　A method according to any of claims 19 to 30, wherein said obtaining step obtains said load balancing information over a measurement interval defined by the received request.

10　32.　　　A method according to any of claims 19 to 31, wherein said received request includes data defining a subset of the cells associated with the base station, and comprising the step of obtaining load balancing information in respect of the cells in the subset and not the cells outside the subset.

15　33.　　　A method according to any of claims 19 to 32, wherein said base station is operable to control handover of one or more associated mobile communication devices to another cell or base station in dependence upon the one or more received resource status update messages.

20　34.　　　A method according to any of claims 1 to 33, wherein said request and response are communicated between the neighbouring base stations over an X2 interface.

35.　　　A EUTRAN base station comprising:

25　　　means for generating a request for resource status information;

means for sending the generated request to a neighbouring EUTRAN base station, and

means for receiving one or more resource status update messages from the neighbouring EUTRAN base station in response to the requested resource 5 status information; and

means for performing load balancing operations in dependence upon the received one or more resource status messages.

36.   A EUTRAN base station comprising:

10   a request generator operable to generate a request for resource status information;

a transceiver operable to transmit the generated request to a neighbouring EUTRAN base station and operable to receive one or more resource status update messages from the neighbouring EUTRAN base station in response to the 15 requested resource status information; and

a controller operable to perform load balancing operations in dependence upon the received one or more resource status messages.

37.   A EUTRAN base station comprising:

20   means for receiving a request for resource status information from a neighbouring EUTRAN base station;

means for obtaining one or more load balancing measurements for resources associated with the base station,

means for generating one or more resource status update messages 25 including the one or more load balancing measurements; and

28

means for sending the generated one or more resource status update messages to the neighbouring EUTRAN base station.

38. A EUTRAN base station comprising:

5 transceiver operable to receive a request for resource status information from a neighbouring EUTRAN base station;

a controller operable to obtain one or more load balancing measurements for resources associated with the base station;

a resource status update message generator operable to generate one or
10 more resource status update messages including the one or more load balancing measurements; and

wherein said transceiver is operable to transmit the generated one or more resource status update messages to the neighbouring EUTRAN base station.

15 39. A computer implementable instructions product comprising computer implementable instructions for causing a programmable computer device to perform the method of any of claims 1 to 34.

20

25

30

Application No: GB0802023.2	**Examiner:** Mr Nigel Hall
Claims searched: 1-39	**Date of search:** 29 May 2008

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	1, 19, 35 - 38 at least	GB 2359701 A (LG Electronics) see abstract; page 5 lines 15-21
A	1,19,35- 38 at least	WO 2006/136422 A ((Siemens) see abstract; page 8, lies 12-13, and 16-18

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

H4L

Worldwide search of patent documents classified in the following areas of the IPC

H04Q

The following online and other databases have been used in the preparation of this search report

Online: EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
H04Q	0007/30	01/01/2006