3GPP TSG-SA5 (Telecom Management) **S5-070974**
Meeting SA5#53, 07 - 11 May 2007, Sophia Antipolis, FRANCE

Source:	Ericsson
Title:	Discussion on Automatic Neighbour Relation Lists for LTE
Document for:	Discussion and approval
Agenda Item:	6.8.4

1 Decision/action requested

To discuss an Automatic Neighbour Relation List function in LTE and decide upon which solution shall be used.

2 References

[1] S5-070862 Draft 32816-020 v1

[2] 36.300 v8.0.0 Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Overall description; Stage 2

[3] R2-07xxxx kljgfjassfj

3 Rationale

The manual planning and management of Neighbour Cell Lists in a Radio Access Network, such as GSM and WCDMA, is resource consuming and error prone. In [1], section 4.1.3, Use Case 2, it is suggested that the LTE standardizes functions for optimizing Neighbour Cell Lists. This contribution takes that idea step further and argues that neighbour Cell Lists should be automated.

One purpose of Neighbour Cell Lists in GSM and WCDMA is to allow the RBS to give their connected UEs a defined set of cells to measure. The need for the list to be short is that when GSM and WCDMA were standardized, it was not feasible to have the UE measure on all possible neighbours. For LTE, the situation is different. It is assumed that a LTE UE can decode any measurement cell identity on a frequency. For this reason, Neighbour Cell Lists as we know them from GSM or WCDMA will not be needed in LTE.

Neighbour Cell Lists will exist in LTE, though, but have a different role. In contrast to GSM and WCDMA, one purpose of Neighbour Cell Lists is to set up connections over the X2 interface between eNodeBs. This role is the reason for this contribution. As the role of the list has changed, we give it a new name: Neighbour Relation List.

We first describe two proposals for automating the handling of Neighbour Relation Lists, and then continue with a comparison of them.

3.1 Introduction

Both proposals cover the case when a new potential neighbor appears for a cell. The Neighbor Relation List for already established neighbor relations is populated for all cells. In the case of a newly established cell, this list may be empty.

Two concepts are central to this contribution, the *Measurement Cell Identity* and the *Cell Identity (PLMN level)*, see [2]. For the purpose of this document, they are abbreviated MCI and CIPL:

- The **Measurement Cell Identity** (MCI) is a Layer 2 identifier for a cell. The MCI is integer, not long enough to be unique for a RAN. We assume the CI to have 510 unique values. The MCI corresponds to the WCDMA "scramble code". When planning the LTE RAN, each cell in the network is assigned a MCI. As there are only 510 MCIs, MCIs are reused. Of course, when planning a network, the planner tries to distribute the MCIs so an eNodeB has no neighbor with the same MCI as itself. Also, the planner tries to distribute the MCIs so an eNodeB does not have two neighbors with the same MCI. However, it is vital to this discussion that one can not guarantee that the attempts to distribute the MCIs are successful. Especially in the case of Home eNodeBs, the planner has much less control over the distribution of eNodeBs than for a traditional RAN.

- The **Cell Identity (PLMN level)** (CIPL) is a Layer 3 identifier for a cell. The CIPL is a unique identifier for a cell. The CIPL is unique, at least within a PLMN, but typically within a country, or even globally. This is FFS [2]. It is assumes that an eNodeB can use the CIPL to address another eNodeB using the X2 interface. Typically, the CIPL can be used in a request to a Domain Name Service (DNS) to resolve the IP address of the eNodeB, serving the cell in question.

The MCI is part of the L2 information broadcasted to all UEs listening to a cell. In other words, a UE doing measurements on a cell will automatically be aware of its MCI. As the CIPL is part of Layer 3, it will not be available to a UE doing measurements on a cell. However, when reaching active state towards a cell, the UE will be aware it the cell's CIPL

An Automatic Neighbor Relation List function will need to execute three steps:

1. A cell needs to be able to determine that a new potential neighbor cell has appeared.

2. The cell needs to be able to determine the identity of the neighbor. This identity needs to be sufficiently unique that an automatic function can use it. (In contrast, a human planner can do with "less unique" identifiers, as she has the ability to employ common sense).

3. Using the identity from the previous paragraph, the eNodeB serving the cell needs to be able to set up a connection to the potential neighbor eNodeB using the X2 interface.

The following two subsections describe two different methods of achieving these three steps.

3.2 Measurement Cell ID Handover

This method relies on the UE to relay identities from one cell to another cell. As described in the previous section, the main point is how to support the situation of a handover to a cell which the currently attached cell does not have a relationship to. See Figure 1:

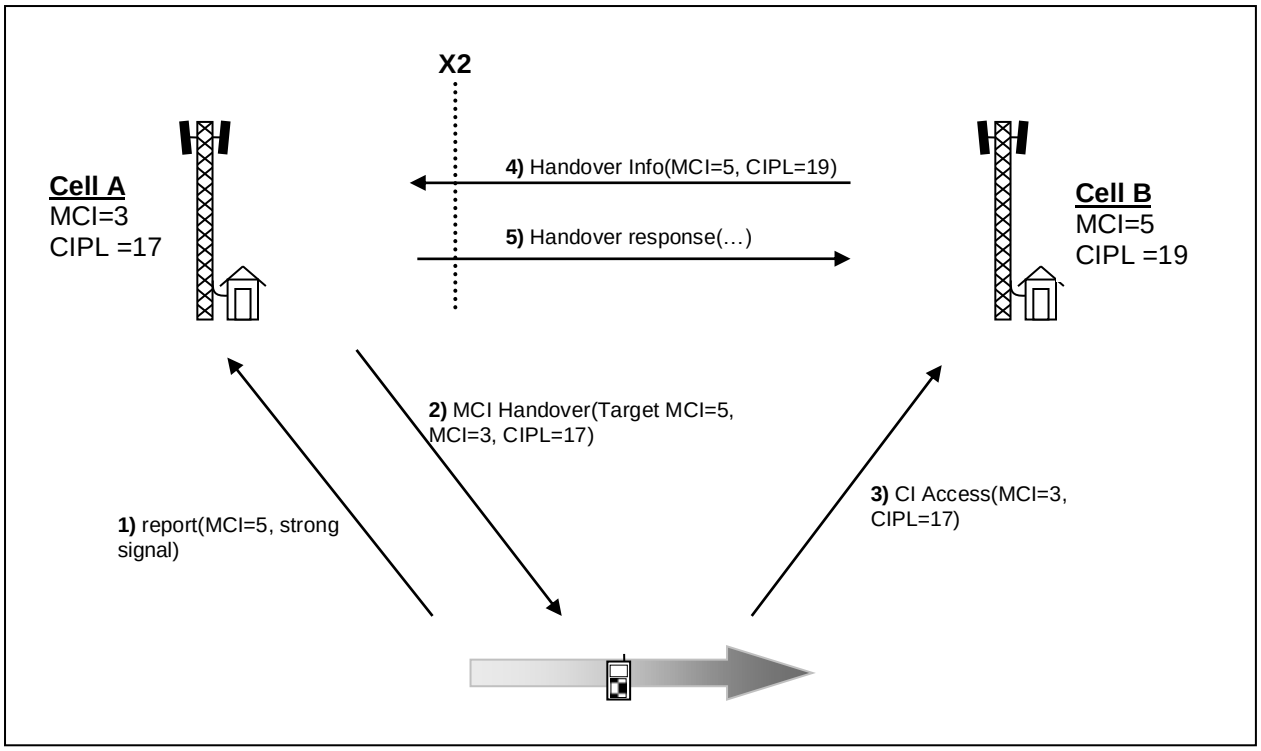

Figure 1. MCI handover

The UE in figure 1 is attached to Cell A. The UE travels towards Cell B. Cell A and Cell B do not have relations to each other, possibly because Cell B is newly installed.

In the following text, the term "Cell A" actually means "the eNodeB serving Cell A". The same goes for Cell B.

Cell A has ordered the UE to make periodic measurements, in order to for Cell A to discover when a handover is needed. Messages are as follows:

1. The UE sends a measurement report regarding cell B. This report contains Cell B's MCI, but not its CIPL. Cell A determines that the UE needs to hand over to Cell B, and starts the "Measurement Cell ID handover" process. (The "Measurement Cell ID handover" process is a handover process where an eNodeB instructs a UE to hand over to a new cell, with the aid only of the Measurement Cell ID of the target eNodeB. The source eNodeB relies on the target eNodeB to start a X2 communication with the source eNodeB. The Measurement Cell ID handover process is FFS.)

2. Cell B issues a Measurement Cell ID Handover message to the UE. It adds its own MCI and CIPL to the message.

3. The UE does a "Cell ID Access" to the new cell. The parameters tell the new cell which cell originated the handover. Note that Cell A is forcing the UE to handover to Cell B, and that Cell A can not be sure that Cell B has the ability to accommodate the UE. However, this procedure should only be necessary once for the (Cell A, Cell B) pair.

4. Cell B sends a "Handover Info" message to Cell A. The message has Cell B's MCI and CIPL as parameters.

At this point, Cell A has all information needed to add Cell B to its Neighbor Relation List. As an X2 connection is established between Cell A and Cell B, Cell B may also add Cell A to its Neighbor Relation List. Whether this symmetry should be used is beyond the scope of this contribution.

3.2 Cell Identity (PLML Level) broadcast

This method relies on cells broadcasting the Cell Global Identifier at regular intervals.

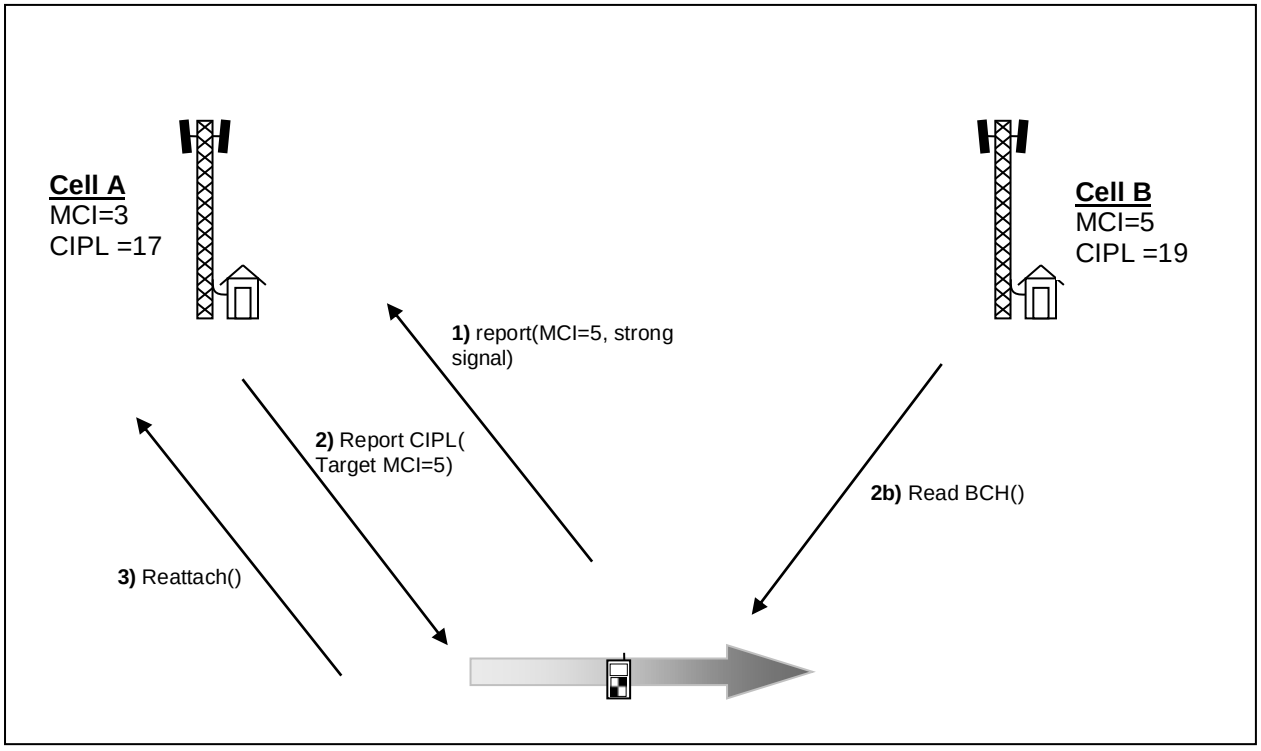

Figure 2: CIPL broadcast

This method works as follows:

A Cell has a Neighboring Relation List. The Cell instructs attached UEs to do measurements on a list of frequencies. The Cell may use different policies for instructing the UE to do measurements, and when to report them to the Cell.

1. The UE sends a measurement report regarding cell B. This report contains Cell B's MCI, but not its CIPL.

When a UE sends measurement reports on a MCI which is not in the serving cell's Neighbor Relation List, the following procedure is used.

2. The Cell instructs the UE to do explicit measurements on the new cell, in order to find the new cell's CIPL. To do so, the UE may need to temporarily interrupt the communication with the serving cell, in order to be able to determine new CIPL of the new cell. The UE listens to the new cell's broadcast of its CIPL.

3. When the UE has found out the new cell's CIPL, the UE reports the detected CIPL to the serving cell.

4. The serving cell uses this information to update its Neighbor Relation List.

The serving cell can now contact the new cell and do a regular handover, if necessary.

3.3 Discussion

Clearly the proposals share global cell identities as a common denominator, something that is important to facilitate non-operator interaction. Both share the idea of identifying neighbour cells with a global cell identity, but they differ in the way of how to retrieve it. In the first alternative, the source cell identity is sent to the target cell – by the UE –

after the handover. In the second alternative, the cell identities are broadcast (on layer 3, system information) and the source cell is informed – from the UE – about the target cell identity.

The benefit with the second alternative is that it is proactive and safe in the way that the network is in complete control of the handover. The network can judge if a new cell shall be a neighbour or not , or if it is suitable for handover of this particular UE. The drawback with the second alternative is that reading broadcast information on layer 3 can be considered expensive for the UE.

The benefit with the first alternative is that the UE is relieved from demanding work. Sending the CPIL on an already established channel from the source cell and having the UE reporting it to the target cell must be seen as a minimal impact. The proposal is robust since a handover will be effectuated even though the target cell is not previously known.

There are some drawbacks with alternative 1 except for the extra communication over X2, S1 or Iub. First, the network can not proactively verify the target cell. Secondly, there is a risk, albeit small, that the target cell cannot establish a contact back to the source cell for some reason. This means that the source cell is not informed about CPIL. Third, supporting IRAT, there is an issue with legacy systems since the networks, and not only the UE, are affected.

To conclude; judging from the benefits of alternative 2 and the drawbacks of alternative 1, we recommend alternative 2.

A contribution for the second alternative is submitted to RAN2 [3]

4 Detailed proposal

The following justifications are proposed to be added to 4.1.3.1:

Neighbour Cell Lists as we know them from GSM or WCDMA will not be needed in LTE. In LTE, Neighbour Cell Lists is needed to set up connections over the X2 interface between eNodeBs. To release operators from the burden of planning, it is important to add abilities in the LTE system. Such an ability is the terminals' capability top uniquely identify a cell in measurement reports.

The following requirements are proposed to be added to 4.1.3.2:

Optimisation of the neighbourhood list

To simplify the cell planning:

1. The CIPL is to be broadcasted in system information, see R2-072044,
2. An active mobile shall be able to, on request from the network, report CIPL for a specific MCI being measured on.

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