3GPP TSG RAN WG1 Ad Hoc on LTE **R1-050629**
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Agenda Item: **4.1**
Source: **Huawei**
Title: **Inter-cell Interference Mitigation**
Document for: **Discussion & Decision**

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1. Introduction

For delivering a uniform user experience across the cell area, it was mentioned in [1], that "cell edge bit rate" should be increased whilst maintaining the same site locations as deployed today. Nevertheless, inter-cell interference is the main reason of "cell edge bit rate" limitation. In last meeting, several contributions [2~4] on Inter-cell interference mitigation or suppression were proposed and discussed. This document categorizes all proposed solutions into two classes, and gives a simple comparison.

2. Background

To reduce or suppress the inter-cell interference, some mechanisms could be imposed to scheduler when UE is located at cell edge. Currently, solutions proposed in RAN1 can be classed into two classes.

Class 1: Interference reduction by frequency allocation

Generally speaking, all subcarriers are divided into two groups in each cell. One group can be called as major subcarriers group, and these subcarriers can be used for UE located near the cell edge and common channels that should cover all area of the cell. The other subcarriers compose minor subcarriers group, which is only used for cell center users. UE with minor subcarriers could be strongly interfered by some major subcarriers from other cells. If it occurs, Node B/UE can stop using these subcarriers and shift to other minor subcarriers with low interference. By proper O&M configuration (Network planning), the major subcarriers should not be overlapped among several neighbouring cells.

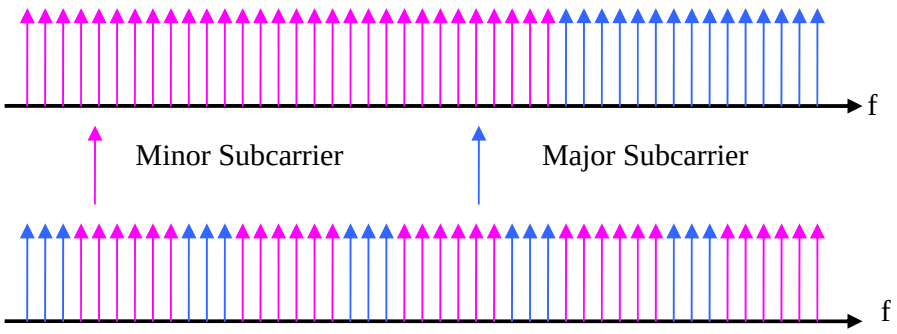

Figure 1 Subcarriers Allocation

Figure 1 is uplink frequency allocation example; Major subcarriers group can be localized or distributed. Here Major subcarriers are indicated with blue colour, while minor subcarriers are indicated with red colour.

Using this kind of frequency allocation, when one UE is located near cell edge, in downlink, it is easy to achieve a good SIR for signal from serving cell because TX power for the same subcarriers in adjacent cells is small. In uplink, similarly, serving cell can receive a high SIR for the signal from this UE since the interference UEs with the same subcarriers in adjacent cells is far away from this UE.

Class 2: Interference reduction by cell coordination

In this solution, interference reduction is realized by real-time coordination among all involved cells to avoid that two cell edge UEs in neighbouring cells use the same subcarriers.

One example, assuming one UE with subcarrier f_0 located Cell1 center from the beginning, when this UE move to the cell boundary between Cell1 and Cell2, after sense the interference from Cell2 and report to Cell1, then the serving cell (Cell1) of this UE shall coordinate with Cell2 to avoid use this sub-carrier f_0 at the Cell2 edge or suppress the Tx power for the UE with f_0 in Cell2. By this kind of real-time coordination, the inter-cell interference can be reduced.

3. Discussion & Comparison

In fact, both classes implicitly make frequency reuse factor larger than one at cell edge (that is the real reason why interference can be reduced). Solution1 is semi-static method by subcarriers (frequency) allocation, while solution2 is a dynamic method by real-time cell coordination.

Class 1:

+ Simple to be utilized
+ No interface among involved cells
…
- Not easy to modify the major frequency distributions among adjacent cells

Class 2:

+ Flexible, no frequency planning is required
…
- Interface between Node B is necessary for coordination
- When subcarriers can be scheduled, much more coordination are required, it can hardly work

(Here is the reason: If adaptive subcarrier allocation technique is employed, Node B will select the DL&UL subcarriers for UE according to UE's channel quality. In other words, subcarriers of one UE perhaps vary frequently. Once subcarriers changes, serving cell of UE has to inform all involved cell about newest subcarriers of this UE, otherwise these subcarriers could be allocate to other UE in adjacent

cells, especially for DL subcarriers. In this case, the number of required coordination could be intolerable.

4. Conclusion

This document addresses two main solutions for inter-cell interference mitigation for E-UTRA. We consider that solution 2 can hardly work in case adaptive subcarrier selection used. So we propose solutions in class1 can be the way for inter cell interference mitigation, and also we don't preclude other solutions based on interference randomisation/averaging mechanism.

5. Reference

[1] 3GPP TR 25.913 V2.0.0, "Requirements for Evolved UTRA and UTRAN"

[2] 3GPP R1-050407, "Soft Frequency Reuse Scheme for UTRAN LTE", Huawei

[3] 3GPP R1-050507, "Interference Coordination in new OFDM DL interface", Alcatel

[4] 3GPP R1-050476, "EUTRA uplink scheduling and frequency reuse", Siemens