3GPP TSG RAN WG1 Meeting #41 **R1-050476**
Athens, Greece, 9 – 13 May, 2005

Source: Siemens
Title: Evolved UTRA uplink scheduling and frequency reuse
Agenda Item: 13.2 Further discussion on Multiple Access Schemes (DL&UL)
Document for: Discussion

1 Introduction

During the RAN1#40bis meeting (Beijing) many documents for the evolved UTRA radio access concept have been presented. Based on our conceptual paper [1] and based on the proposal in [2] we investigated further in uplink issues on frequency re-use and scheduling issues.

In general, a "single carrier" approach is advantageous for uplink transmission due to the low PAR. Therefore, we show a possibility for the carrier mapping both in localized FDMA and in distributed FDMA schemes. Note, distributed FDMA is often referred to as interleaved FDMA (IFDMA).

Since this document is for discussion and only shows the general principle we prepared a **set of slides** which are attached to this document. Following the ongoing discussion of the uplink numerology we will adapt the numbers and will show more details in later meetings.

2 References

[1] R1-050260, Siemens, "Multiple Access Scheme Evaluation for the SI 'Evolved UTRA and UTRAN' uplink", *RAN WG1 #40bis*, April 2005

[2] R1-050448, Ericsson, Fujitsu, Motorola, Nokia, NTT DoCoMo, Panasonic, Siemens, "Basic principles for the Evolved UTRA radio-access concept", *RAN WG1 #41*, May 2005

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Evolved UTRA uplink scheduling and frequency reuse

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Overview

- **Common view and problems**
  - Localized and distributed FDMA approaches (so-called "single carrier") seem feasible
  - Intercell interference in case of re-use 1
  - In some cases scheduling is difficult or disadvantageous
- **Solution**
  - Reserve some frequencies (sub-carriers) at the cell edges
  - Reserve other frequencies which can be used with re-use 1
  - Network planning in advance
- **Multiple Access Methods**
  - FDMA / IFDMA dependent on … (FFS)
  - Additionally TDMA or even CDMA, if needed

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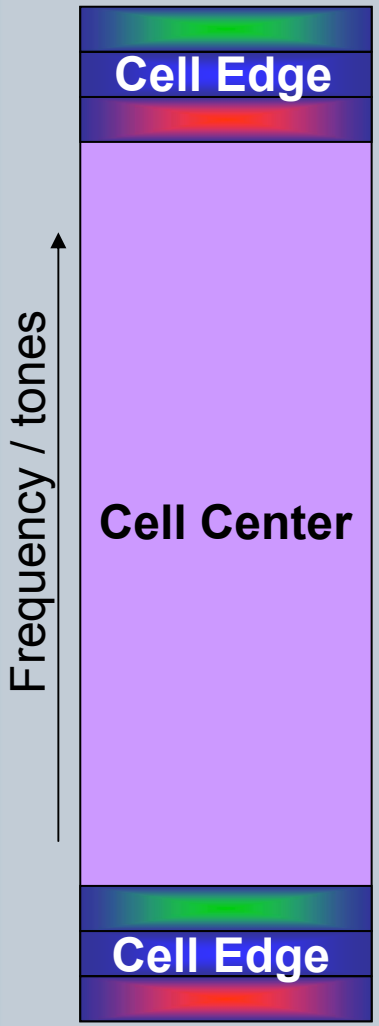
Sub-carrier mapping in case of localized FDMA



Reserved area for CEU‘s

Allowed for cell1, forbidden for cell2,3
Allowed for cell2, forbidden for cell1,3
Allowed for cell3, forbidden for cell1,2

Reserved area for CCU‘s

Example:
FDMA with flexible bandwidth
frequency domain scheduling
Also IFDMA could be used

CEU: cell edge users (high power)

CCU: cell center users (low power)

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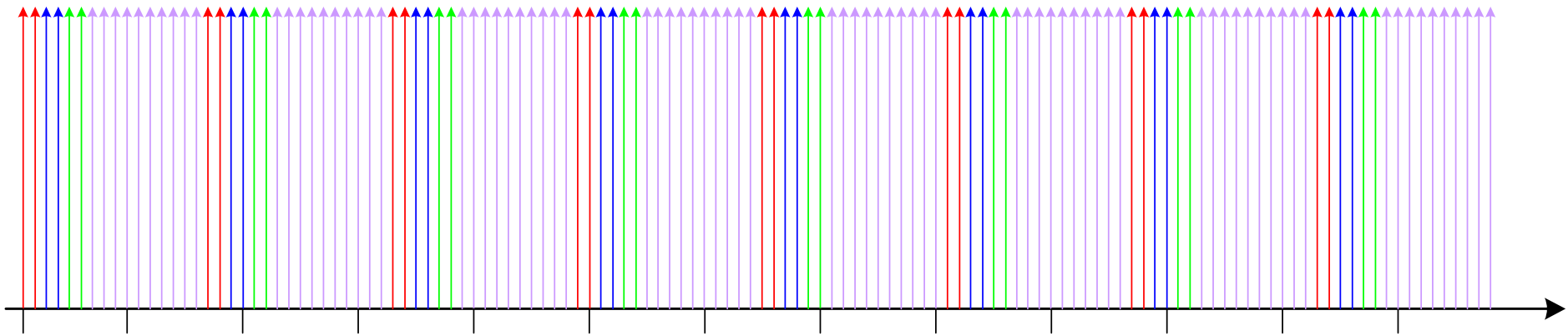
Sub-carrier mapping in case of distributed FDMA

Example

- 128 tones
- IFDMA comb with 8 tones
- 2*8 tones for each cell at the edge (3 cells), *marked red, green and blue*
- Residual 8*10 tones in the cell center, *marked purple*



- Cell 1 can use *red* tones at the cell edge and *purple* tones in the cell center
- Cell 2 can use *blue* tones at the cell edge and …; cell 3 *green* tones

- Localized FDMA could be applied within one block of *purple tones*

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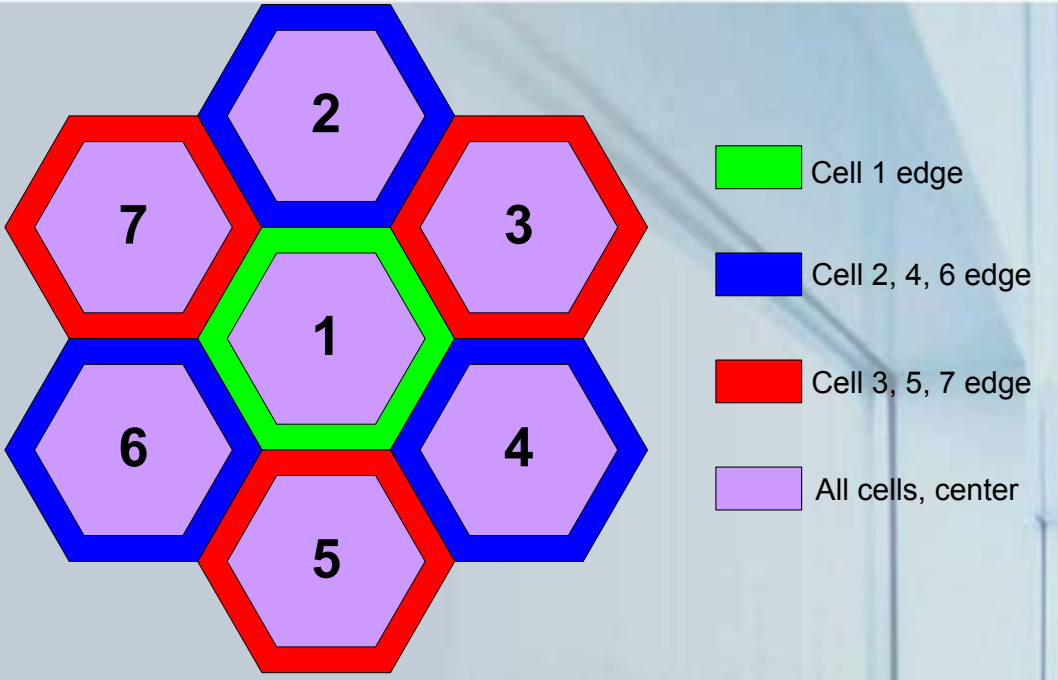
Frequency reuse



- **Remarks to reserved sub-carriers**
  - Cell 1 may use red and blue sub-carriers in the center:
    - if interference from cells 2 – 6 is quite small
    - if UE does not interfere too much from cell 1 into others (close to Node B)

  e.g., in cell 1 red tones could be used,
  if the users of the red tones in cell 3,5, and 7 are far from cell 1
  and a user of the red tones in cell 1 does not interfere into cell 3, 5, and 7.

- **It is for FFS if re-use of 3 is sufficient**.

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Measurements

- **Measurements for frequency reuse**
  - Distance to NodeB
  - Better: intercell interference
    - decision if capacity is reduced more by bandwidth reduction or by intercell interference

Frequency reuse 1 | Frequency reuse 3

$$W \cdot \log_2\left(1+\frac{P}{N+I_{\text{intra}}+I_{\text{inter}}(\vec{p})}\right) \overset{?}{<>} \frac{1}{3}\cdot W \cdot \log_2\left(1+\frac{P}{N+I_{\text{intra}}+I_{\text{inter}}^{reuse}(\vec{p})}\right)$$

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Flexibility for scheduling

- **Flexibility of distributed FDMA**
  - Use only every 2nd, 4th, 8th, ... tone of the comb
  - Group the comb
    - like 1st half, second half
    - unequal groups like 2/5th and 3/5th are possible,
      e.g. (from slide 4): use tones 1,17,33 for user 1
      and tones 49,65,81,97,113 for user 2
- **Flexibility of localized FDMA**
  - Variable bandwidth of carriers, n times sub-carrier bandwidth
- **Parallel use of localized and distributed FDMA is FFS**

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