**3GPP TSG RAN #18** **Tdoc RP-02-0775**

**New Orleans, USA**

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**Agenda Item:** **8.1.4**

**Source:** **IPWireless and InterDigital**

**Title:** **Modification of the MIMO WI to include TDD**

**Document for:** **Discussion and approval**

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# 1 Introduction

Within the HSDPA study item, it has been agreed that MIMO offers significant performance gains with acceptable impact to both UE and UTRAN. Currently the focus of the MIMO work item is on the frequency division duplex mode. The work item to date has concentrated upon the spatial channel model which is applicable to both duplex modes of the air interface. In this Tdoc we propose that the work item description is amended in order to incorporate the time division duplex air interface mode.

# 2 Modified Work Item Description

The proposed modified work item description results in the following modifications to the work item description sheet.

| **Affected existing specifications** | | | | |
|---|---|---|---|---|
| Spec No. | CR | Subject | Approved at plenary# | Comments |
| 25.211 | | Physical channels and mapping of transport channels onto physical channels (FDD) | RAN #20 | |
| 25.212 | | Multiplexing and channel coding (FDD) | RAN #20 | |
| 25.213 | | Spreading and modulation (FDD) | RAN #20 | |
| 25.214 | | FDD : Physical layer procedures | RAN #20 | |
| 25.215 | | Physical layer measurements (FDD) | RAN #20 | |

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| 25.221 | | Physical channels and mapping of transport channels onto physical channels (TDD) | RAN #20 | |
| 25.222 | | Multiplexing and channel coding (TDD) | RAN #20 | |
| 25.223 | | Spreading and modulation (TDD) | RAN #20 | |
| 25.224 | | Physical layer procedures (TDD) | RAN #20 | |
| 25.225 | | Physical layer – measurements (TDD) | | |
| 25.331 | | Radio Resource Control (RRC) Protocol Specification | RAN #20 | |

## 3 Text Proposal for TR

The proposed alterations to the work item description shall impact the following sections of the MIMO Technical report TR 25.876 v1.1.0:

# 4 Requirements for the evaluation of techniques for Multiple-Input Multiple-Output antenna processing

The following considerations should be taken into account in the evaluation of the different techniques proposed for MIMO antenna processing.

1. The focus will be on frequency division duplex HSDPA using MIMO antenna processing techniques and on the additional or modified uplink signaling required to support MIMO. High chip rate time division duplex HSDPA using MIMO antenna processing will also be considered.

2. Requirements for the evaluation of techniques for HSDPA will apply to the MIMO techniques unless otherwise noted. .

3. Specifications which are not explicitly stated in this technical report will follow those found in the HSDPA TR.

4. MIMO proposals shall be comprehensive to include techniques for 1, 2 or 4 antennas at the Node B and 1, 2, or 4 antennas at the UE. In this document, we will use the notation (*x*,*y*) to denote a system with *x* Node B antennas and *y* UE antennas. Therefore any proposal shall

cover one or more of the following antenna configurations and be restricted to only these: (1,1), (1,2), (1,4), (2,1), (2,2), (2,4), (4,1), (4,2), (4,4).

5. For each transmit/receive antenna configuration, the transmission techniques for the range of data rates from low to high UE geometry shall be specified.

6. The configurations of the multiple antennas at both the Node B and UE shall be specified.

7. The channel quality metric used for rate adaptation shall be specified.

8. The semantic associated with the feedback bits from the UE to Node B and the use of these bits shall be specified.

9. Higher-level signalling on both uplink and downlink at the time of call set up through RRC messaging shall be specified.

10. Real-time control and signalling bits (physical layer messages) transmitted on the downlink shall be specified. These bits are ancillary information to the traffic channel (e.g., HS-DSCH) that will be used by the UE in properly decoding the traffic channel transmitted by Node B. The information contained in it could included information such as explicit rate (or MCS level), antenna mode, etc.

11. A description of the receiver algorithms shall be specified.

12. The impact on non-MIMO UEs shall be specified. An analysis of its complexity shall be provided compared to Release 5 HSDPA solutions (both UEs and node Bs), especially in terms of RF complexity, memory requirements, requirements on UE size, computational complexity, algorithm (hardware) reusability, signalling requirements. An analysis of migration from Release 5 to MIMO should also be provided in terms of, for example, antenna configurations and techniques.

13. The overall goal with introducing MIMO is to strengthen the WCDMA system as a reliable and cost effective access technique for HSDPA in urban and sub-urban areas. This means the goal is to increase the number of HSDPA users, and/or to increase their coverage compared to Release 5 HSDPA systems.

14. MIMO systems should be optimized for low- to medium-speed scenarios.

15. MIMO should be optimized for interactive and background services.

# 10 Annex A: Simulation assumptions and results (FDD)

While eventually MIMO schemes will be combined with the H-ARQ schemes it is expected that because of complexity the initial simulations will not incorporate the H-ARQ aspects. We propose three sets of simulations to focus on : link, single-user throughput, system. The spatial channel models for link and single-user throughput simulations are specified in Annex B. A summary of the simulation assumptions is given in the table below.

| **Item** | **Requirement** | **Comment** |
|---|---|---|
| Number of Antennas (# @ NodeB x # | Base case (1x1), 1x2, 1x4, 2x1, 2x2, | Antenna configuration to be specified |

| | | |
|---|---|---|
| @ UE) | 2x4, 4x1, 4x2, 4x4 | by proponent |
| Feedback bits on UL | Max 2 bits/slot 4% or 10% bit error rate | Feedback bits are incremental to HARQ, and includes Channel Quality Metric (Need to be specified in proposal) and antenna mode indication (if needed). Additional bits may be allowed if they result in significant performance gains |
| Feedback Delay | Total round-trip feedback delay of 7 slots | Each proposal shall include a timing diagram to justify the value of round-trip feedback delay if a different one from 7 slots is used |
| Power Fraction available for data and pilot power on optional antennas 3 and 4 | 75% | |
| Fractional Recovered Power | 98% per Receive Antenna | |
| Channel Model | Initially 1 Path Rayleigh and IID | 1 path Rayleigh used for calibration of results. Use test cases as specified in the MIMO channel model |
| Doppler | Base cases 3 Km/h,  30 Km/h, and 120 Km/h | |
| MCS | The maximum number of MCS levels is 32 levels for 2 transmit antenna systems and 64 levels for 4 transmit antenna systems | Max rate over 4x4 (~21.6 Mbps). |
| SF and maximum number of codes available for MIMO | 16 and 10 respectively | Optional support up to 15 codes. |
| TTI | Fixed (3 slots) | . |
| Pilot powers | **Case 1:** For two transmit antennas, total pilot power shall be 10% of total downlink power (same as Rel 99). For optional antennas 3 and 4, the total pilot power should be taken out of the 75% power specified above.<br><br>**Case 2**: Total pilot power shall be 10% of total downlink power, with pilot power divided evenly among the multiple antennas | For Case 1, ratio of powers among antennas can be specified by the proponent. |
| Scheduler | As in HSDPA Feasibility report | |

## 10.1 Link-level simulations

Link-level simulations provide frame error rate versus $I_{or}/I_{oc}$ for any of the proposed transmitter and receiver options. The spatial channel model is specified in Annex B below. The following assumptions are also made.

- A maximum 70% of the total downlink power is used for the downlink shared channel.
- A spreading factor 16 is used, and a maximum of 15 orthogonal spreading codes can be used for the downlink shared channel.
- The maximum fraction of recovered power is 98%. This translates to a specified maximum instantaneous "C/I" per receive antenna. Note that receive antenna combining can result in instantaneous "C/I" higher than prior to receive antenna combining.
- A fixed TTI of 3 slots is used.

### 10.3 System-level simulations

System-level simulations to obtain performance metrics such as Packet Call, Service, OTA etc. are performed according to the system-level simulation assumptions (antenna response pattern, traffic model, scheduler etc.) in the HSDPA TR [1]. Relevant assumptions for the link-level and single-user throughput simulations are made for the system-level simulations.

In addition to the link level simulation assumptions made above, we assume the following.

- A maximum of 2 bits per 0.667ms slot of feedback information from the UE to the Node B is used. These feedback bits are a generalization of the channel quality indication bits used in single-antenna HSDPA systems, and the interpretation of these bits shall be specified by the proponent of the proposal. Note that these bits could be used jointly over multiple slots to indicate a message. Also the bits specified here do not include the bits required for signalling for hybrid ARQ, such as ACK/N-ACK bits. Additional bits may be allowed if they result in significant performance gains.
- The total round-trip feedback delay is 7 slots. If the delay is different for a given proposal, the proponent will include a timing diagram to justify its value of round-trip feedback delay.

## 10A Annex A1: Simulation assumptions and results (TDD)

{Editors note: This section will describe the simulation assumptions and results applicable to the time division duplex mode.}

## 4 References

[1] 3GPP TR25.876 v1.1.0, Multiple-Input Multiple Output Antenna Processing for HSDPA.

[2] Work item description sheet, Multiple Input Multiple Output antennas (MIMO).