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Technical Report

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Foreword

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

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1 Scope

This document captures the working assumptions and evaluation criteria of the different techniques being considered for Multiple-Input Multiple-Output (MIMO) antenna processing systems in High Speed Downlink Packet Access (HSDPA).

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 25.950 v4.0.0 UTRA High Speed Downlink Packet Access

[2] 3GPP TR 25.855 v0.0.5 UTRA High Speed Downlink Packet Access

3 Background and introduction

In RAN#11 plenary meeting a work item was approved for Multiple-Input Multiple Output antenna processing for HSDPA. The work item includes techniques using multiple antennas at the Node B transmitter and UE receiver to increase throughput, reduce delay, and achieve higher peak rates compared to single-antenna HSDPA systems.

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 signalling required to support MIMO.
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.

13. An analysis of its processing complexity, memory requirements, and front-end linearity characteristics shall be provided.

5 Basic physical layer structure of HS-DSCH for MIMO

{This section should describe the HS-DSCH physical layer structure which is distinct from the non-MIMO HSDPA system.}

6 Adaptive modulation and coding schemes

6.1 Modulation and channel coding

{This section should describe the range of HS-DSCH modulation and channel coding options, including rate matching.}

6.2 Transmission algorithms

{This section should describe the incorporation of the modulation and coding options and distribution of data streams to the multiple transmit antennas.}

6.3 Physical layer aspects for MCS Selection

{This section should describe the physical layer aspects of the MCS selection e.g. what measurements are needed (if any) and also what signalling (uplink and downlink) is needed to support Adaptive Modulation and Coding . It should describe the channel metric used for MCS selection and the interpretation of the feedback bits at the Node B.}

7 Associated Signalling

7.1 Downlink

{This section should describe the HS-DSCH-related downlink signalling which is distinct from the non-MIMO HSDPA system.}

7.2 Uplink

{This section should describe the HS-DSCH-related downlink signalling which is distinct from the non-MIMO HSDPA system..}

8 UE Capability

{This section should describe the parameters(e.g. number of antennas, modulation, codes etc.) based on which the UE capability are classified. It should also describe the receiver algorithms used for each antenna configuration and transmission algorithm.}

10 Annex A: Simulation assumptions and results

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 # @ UE)	Base case (1x1), 1x2, 1x4, 2x1, 2x2, 2x4, 4x1, 4x2, 4x4	Antenna configuration to be specified by proponent
Feedback bits on UL	Max 2 bits/slot	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. In addition, 64-QAM can be used and it only has to be taken into account in the complexity evaluations.	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. **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.

11 Annex B: Spatial Channel Model

12 Annex C: History

V 0.0.0	Aug 2001	Presented at RAN WG1 #21 Turino as R1-01-0879	
V 0.0.1	Nov 2001	Presented at RAN WG1 #22 Jeju as R1-01-1127	Incorporate minor revisions from reflector and RAN WG1 #21 meeting.
V 0.0.2	Nov 2001		Incorporate minor revisions from RAN WG1 #22 meeting
V1.0.0	Dec 2001	Presented to RAN #14 Kyoto	