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Title: Enhanced UE receiver performance requirements for HSDPA

Document for: Discussion

1. Introduction

This document discusses different methods and reference implementations for defining receiver performance improvements for HSDPA UE.

In [1] it is proposed to create a work item to enhance performance requirements for HSDPA by defining requirements for receiver diversity, excluding all other possible performance enhancements. This is justified in [1] to be valid approach due to robust structure offering enhanced cell capacity and coverage with increased peak data rates. Main driver for this as given in the references [2] and [3] is to find a solution, which enables a quick definition of new performance requirements neglecting any possibility to consider potential tradeoffs.

We recognise that enhanced cell throughput and peak data rates are attributes that should be considered when defining performance improvements. However, we also see that in some cases it is useful to leave a freedom of UE implementation to a terminal manufacturer and not to define the improvements based on only one reference implementation since one single receiver type is not likely to offer the most optimum and best performing solution in all scenarios. Hence, we would like RAN4 to define the performance improvements for HSDPA while considering different reference receiver structures in order to benefit the industry as whole by maintaining the best evolution from the market perspective.

In following sections we discuss the complexities and costs of receiver diversity and chip-level equalizer and how achievable performance gains are dependent on a selected environment and how realistic assumptions are used.

The aim of this document is to show that from the performance and complexity point of view there also exist other attractive solutions, which could be considered as a basis of HSDPA performance enhancements, in addition to the one proposed in [1].

2. Cost and Complexity

Incremental steps in technology improvements are usually the most cost efficient way of implementing the improvements and they allow the improvements to be available on the market within a shorter time frame. Hence it is briefly discussed here about different issues related to cost and complexity of an HSDPA receiver.

The cost structure between different elements of a terminal (e.g. RF and base band) is quite different for chip-level equalizer and receiver diversity. Based on our internal analysis the cost of implementing receiver diversity to a terminal is higher than the cost of implementing a chip-level equalizer. The actual cost and complexity are, however, closely related to the selected architecture of a terminal and therefore it is difficult to make absolute comparisons between different enhancement methods. This is also the reason why we believe that implementation freedom in performance improvements provides the best advantage in the end.

3. Performance enhancement considerations

In [2] simulation results were shown for uncorrelated channels (i.i.d.), which represent the best case for the performance of receiver diversity. It is a well-known fact that achievable gains with receiver diversity are highly dependent on the selected assumption of the correlation of the fading between diversity branches. In practise even with equal antenna

gains, without any amplitude or phase imbalance between diversity branches and assuming ideal isolation between antennas, there will be a certain degree of correlation between the received signals of the receiver diversity branches in realistic radio propagation conditions. A degree of correlation is naturally dependent on an operational environment.

Assuming fading conditions between the UE diversity antennas to be completely uncorrelated (i.i.d) larger relative gains over the RAKE are likely to be experienced with receiver diversity than with chip-level equalizer. However, if more realistic situation with correlation between the fading of the diversity antennas is investigated, the gains of receiver diversity compared to the RAKE are likely be reduced, where as the gains of chip-level equalizer are expected to remain practically unchanged. Thus, the requirements based on receiver diversity as proposed in [2] will provide gain in some cases, but also other solutions could be possible and attractive.

Since the robustness and attainable gains of a given improvement method are substantially dependent on the selected scenario, it is difficult to identify one optimal solution for all cases even in terms of performance. Furthermore, our internal complexity analysis shows that there are some other less complex and more cost effective solutions than receiver diversity, and therefore it would be beneficial not to exclude these other solutions like chip-level equaliser from the RAN4 work targeting to enhance the system performance of HSDPA.

In our opinion different reference receivers should be considered when enhancing the performance requirements for HSDPA. We also feel that the solution should not be specified, but instead focus should be put on improvements in the needed performance areas. Furthermore, the specifications should not consider nor define any specific implementation, since this principle is not beneficial for the industry when looking at it with a broader perspective. Instead we should identify urgent areas for improvements and allow industry to develop cost optimised solutions to meet these requirements.

4. Proposal for a way forward

It is recognized that improvements in terms of performance is needed as market evolves. Hence, we propose the following way forward for enhancing the receiver performance of HSDPA UE.

- The specifications do not determine any specific implementation in the areas where it is functionally compatible for the system. This enables manufactures to optimise their implementation to meet the market demand and performance requirements defined by RAN4.
- RAN4 uses general UE receiver improvements for defining HSDPA performance enhancements.
    - RAN4 introduces performance enhancements to the specifications in the areas where improvements are found necessary. Unnecessary enhancements should be avoided, since tendency to increase complexity of the equipment is likely to decelerate the deployment.
    - Realistic simulation assumptions will be used in order to identify real improvements for end user performance and for the whole system.

5. References

[1] RP-030654 New WI proposal: Performance Requirements of Receiver Diversity for HSDPA, NTT DoCoMo

[2] R4-031135, Performance Requirements of Receive Diversity for HSDPA, NTT DoCoMo

[3] R4-031135, Proposed Work Item Description on “Performance Requirements of Receive Diversity for HSDPA”, NTT DoCoMo