TSG-RAN WG1, Meeting #15 **R1-00-1120**
Berlin, Germany, 22-25 August, 2000

Agenda item:

Source: QUALCOMM Europe

Title: Issues for consideration in the HSDPA report

Document for: Discussion

Summary:

This contribution, submitted for discussion, presents issues for consideration in the evaluation and comparison of technologies proposed for High Speed Downlink Packet Access, HSDPA.

1. Introduction

To optimize forward link high rate packet transmissions it will be necessary to decide among a number of different options. Since different companies typically use different simulation assumptions, parameters, and platforms a common framework is necessary to assess the different proposals and to choose the combination providing the most effective overall solution. We present considerations for this framework.

The need for common assumptions is the focus of [1] and [2]. In addition, other contributions have raised issues for study (e.g., [3] and the references therein). The objective of this contribution is to provide additional input to the overall effort and to help formalize the basis for evaluation and comparison.

2. Metrics for Comparison

2.1 Throughput

Both total system throughput and distribution of throughputs among users are needed. The latter is needed to assess the fairness of the algorithms. Algorithms emphasizing only total throughput based on C/I alone will "starve" users with low geometries (i.e. the ratio between the total power received from the target cell to the total power received from other cells is low). Thus, results should report

- Total throughput for all the users in a sector, subject to all users, except 0,1,or 2 %, getting a minimum throughput of $T_{\min}$ kb/s. $T_{\min}$ is a minimum throughput implying a "throughput outage" for the 0, 1, or 2 % of users not getting $T_{\min}$ kb/s.
- Distribution of user throughputs in the sector as a function of geometry, with users segregated by mobile velocity and fading condition.

2.2 Delay

The following metrics should be available for evaluation and comparison:

- Average and standard deviation for all the users in a sector.
- Distribution of user delay means and standard deviations in the sector as a function of geometry, with users segregated by mobile velocity and fading condition.

3 Issues related to HSDPA techniques

3.1 Higher order modulation

A key issue is the maximum C/I that can be expected taking into account practical limitations such as

- waveform ICI,
- radio noise floor,
- timing errors,
- adjacent channel interference,
- ADC quantization.

Without accounting for these, very high C/Is can be calculated, suggesting very high order modulation. Taking account of these limits makes C/I's higher than 13-15 dB unlikely, therefore limiting the modulation order.

Thus, proposed higher order modulations should show how these issues are accounted for. Questions have already been raised about 64 QAM (and even 16 QAM, [3], Sect. 2.1) and it might be ruled out at an early stage, simplifying design.

3.2 Scheduling Algorithm

The choice of scheduler is critical to the issue of the tradeoff of total throughput vs. fairness. Two extreme examples are transmitting to the user with maximum C/I and round robin, the former emphasizing total throughput, and the latter, fairness. There are intermediate strategies such as in [4]. This type of algorithm is shown in [5] to provide an attractive compromise between throughput (by taking advantage of good channel conditions) but yet still giving approximately the same amount of transmission time to all users. With a performance metric including fairness as well as throughput, it is likely that neither a maximum C/I algorithm nor a round robin algorithm will be adequate.

3.2.1 Rate feedback for scheduling

The maximum rate for a particular packet transmission may be sent from the UE to the RNC or Node B or determined directly in Node B (as suggested, e.g., in [6]). The different methods should be compared with respect to accuracy, delay, and messaging load on the reverse link.

3.3 Interference interaction within and between cells

The effect of abruptly changing loads should be investigated and taken in to account since these could cause instabilities in the network, in particular when voice and data

users share the same spectrum. The sudden initiation of a transmission of a high power data user in one sector will cause significant additional interference in its own sector (with multipath) and in other sectors. This will cause the power controlled users (e.g. voice users) to react, further increasing interference. At least a transient will occur and possibly a longer reaction.

3.3 Power Control

The role and method of power control needs to be specified. For example, scheduling may use all the available power for one data user, or divided up among data users using power control feedback.

3.4 Handoff Issues

Soft handoff situations should be considered:

- If data users are in soft handoff, then modifications to scheduling, with its required estimation, needs to be considered
- If data users are not put into soft handoff, then the effect of large transmitted powers and possible coverage holes need to be considered.

For fast cell site selection, synchronization issues and the fact that the reverse link may be overloaded or has fading uncorrelated with the forward link should be considered. The lack of correlation on the two links can, especially in slow fading, cause unreliable handoff decisions to be made.

3.5 Estimation accuracy

Channel sensitive scheduling and higher order modulation, at least, require estimations. The following should be reported:

- Estimation accuracy required for effectiveness
- Estimation accuracy in the reported simulations
- Sensitivity to estimation accuracy

3.6 Interaction with other layers

This should include interaction with TCP:

- Effects of transmission and retransmission delays upon TCP timeouts, flow control
- Reduction of throughputs defined above due to TCP interactions.

References

1. Ericsson, Motorola, Nokia, “Common HSPDSA system simulation techniques,” R1-00-0000, 3GPP TSG RAN WG1 #15, 22-25 August 2000.

2. Ericsson, Motorola, Nokia, “Link Evaluation Methods for High Speed Downlink Packet Access (HSDPA)”, R1-00-0000, TSG-RAN WG1 #15, 21-24 August 2000.
3. Nokia, “Considerations on High-Speed Downlink Packet Access (HSDPA),” R1-00-0868, 3GPP TSG RAN WG1 #14, 4-7 July 2000.
4. A. Jalali, R. Padovani, R. Pankaj, “Data Throughput of CDMA-HDR, a High Efficiency Data Rate Personal Communication Wireless System, ”VTC’2000, pp. 1854-1858.
5. J.M. Holtzman, “CDMA Forward Link Waterfilling Power Control,” VTC’2000, pp. 1663-1667.
6. Panasonic, “Fast DSCH scheduling function”, R2-00-1053, 3GPP TSG RAN WG2 #13, 22-26 May 2000.