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Agenda Item:
Source: Rapporteur (SK Telecom)
Title: Draft report on e-mail discussion on USTS
Document for: Information

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1 Introduction

There were some comments on USTS via e-mail. This is the summary of them.

2 Report of the e-mail discussion

Several e-mails by Ericsson, LGIC, Nokia, and Siemens appeared on the reflector.

Questions by Ericsson

- Is aij the instantaneous path gain or the average path gain (average over the fast fading)? I get the feeling it is the instantaneous path gain but that would imply that Eb/Io is the instantaneous value. What is then averaged in the E[...] of the denominators of e.g. (2.3). If it is the average path gain, then I would assume Xi =1.

Answer by SK Telecom :

First, aij is the instantaneous path gain. Second, the sum of interference from other users is well approximated as a Guassian noise, when observed over a short-term time interval (which is defined as a time interval enough to remove those due to shadowing), due to central limit theorem for a large number of users. So I used this approximation [1,2,3] and thus, the transmission quality can be evaluated using the signal energy per information bit-to-short term average interference plus background noise power spectrum density ratio Eb/Io. The term "E[...]" of the denominator of (2.3) means the short term average of "...".

[1] C. Kchao and G. L. Stuber, "Analysis of a direct-sequence spread-spectrum cellular radio system", IEEE Trans. Commun., vol 41, pp. 1507-1516, Oct 1993

[2] E. Geraniotis and B. Ghaffari, "Performance of binary and quaternary direct-sequence spread-spectrum multiple-access systems with random signature sequences" IEEETrans. Commun., vol. 39, pp. 713-724, May 1991

[3] F. Adachi, K. Ohno, A. Higashi, T. Dohi, and T. Okumura, "Coherent multicode DS-CDMA mobile radio access," IEICE Trans. Commun., vol E79-B, pp. 1316-1325 Sep 1996

- I do not fully understand the meaning of the labels (1/8, 1/8), (1/8, 10), and (10,10) in figure 3.1. Especially, I do not understand what is meant by "synchronization of the fist path is carried out with 1/8 of a chip duration and multipath components within 10 chips." The relative position of the rays is fixed according to the channel model, correct? if that is the case, the disalignment of the different rays should be the same.

Answer by SK Telecom :

Yes, according to the channel model used in the drafts, if the first significant path is aligned within 1/8 chip duration, the other multipaths are also aligned. So, (1/8,1/8) is for USTS and (10,10) corresponds to non-USTS. But this channel model is just a model and in real environments the delay between the first significant path and the others is not constant.

- A more general comment is: what is the probability that, with this scheme, the uplink capacity would be code limited instead, i.e. there is no gain in capacity`?

Answer by SK Telecom :

In order to prevent the possible channelisation code shortage problem, more than one scrambling codes can be assigned to one cell at the expense of capacity (interference-limited) because orthogonality is guaranteed only for UEs using a common scrambling code.

Questions by Siemens

- In the overview document it is stated that the USTS scrambling code will be as in TS 25.213 section 4.3.2.2. However this is an HPSK long scrambling code. Also in 25.213 the current UE specific OVSF rule is optimised for PAPR (peak to average power ratio) in HPSK. Putting more OVSF nodes into use (e.g. as in related Tdoc 873) will surely mean that a UE using USTS will have a worse PAPR than a R99 UE? Would this limit maximum range?

Answer by SK Telecom :

USTS uses the same HPSK long scrambling code, i.e., the complex-valued long scrambling sequence Clong,n at the bottom of pp 12 in section 4.3.2.2 of TS25.213. The comments related to Tdoc873 will be answered by samsung ASAP.

- The performance paper stresses indoor and pedestrian use (with no other cell effects). Is this the intended emphasis of USTS?

Answer by SK Telecom :

At this point, handoff is not supported in USTS mode as I mentioned in section 2.4 of the performance paper. Therefore, we're now considering USTS is suitable for slowly-moving terminals. And we cannot expect macro-diversity gain, which can be obtained by soft handoff in non-USTS mode. Current performance paper is focused on single cell systems. But there are many papers about the other cell effect and those results can be directly applied for USTS. For example, the ratio of other cell interference to own cell interference can be used to estimate the multiple cell capacity gain of USTS compared to non-USTS. In indoor environments, the other cell interference effect is relatively small and the performance of USTS is better as this other cell effect becomes smaller. What I want to say are:

1) Handoff is not impossible for USTS but it (especially, soft handoff) requires much changes to current specifications. Our intention is to support USTS with as small modifications as possible.

2) The performance of USTS was evaluated mathematically and by simulations. The performance gain was obtained and the effects of many parameters were investigated. In most cases, we can expect 50 % - 100 % gain by using USTS in a single cell system and we can easily estimate the gain in a multiple cell system, referring to e.g., the ratio of other cell interference to own cell interference. The multiple cell gain is expected to be smaller than single cell gain but in some environments such as indoor, the gain is still high.

- The JTC model is used for one simulation and the ITU model in another. Is this to show different effects operating on USTS? Also your y-axis is denoted in SIR dB or MAI dB, have you instead results showing cell capacity increases? This latter is not strictly necessary but would give a more direct indication of the deployment benefit.

Answer by SK Telecom :

Only in Fig. 3.3 "The effect of timing control rate", MAI was used. In all other figures, SIR was used as y-axis label. And ITU model was used only for FIg. 3.3. I'm sorry if this makes any confusion. From the mathematical analysis, the relation between Eb/Io and capacity (# of supportable users) can be found and by using a simple relation between Eb/Io and SIR, we can estimate the capacity from SIR results.

Questions by Nokia

- I was reading the performance study document with interest but there is one thing that is a bit confusing. In the mathematical analysis section it seems that you assume that the multipath profiles of all UEs when seen in the Node B become aligned in time domain when USTS is employed. This way the Eb/N0 becomes GL/N(L-1) and the gain over non-USTS is 100% for L=2. This is represented by (1/8, 1/8) in the simulation charts, I believe.

Answer by SK Telecom :

According to the channel models which are usually used for performance evaluation, the delays between the first path and the other paths are constant.

- However, I fail to see how all the multipaths could be aligned with USTS. If the UEs are not co-located in the cell the multipath profiles are also different. One can align one set of paths with USTS but the other multipaths would still arrive at separate time instants and they would have no orthogonality. In the mathematical analysis section only the equation for S0a0j would be simplified (assuming path 0 is the most significant one); the other paths Siaij would have interference similar to that of non-USTS case. This is represented by (1/8, 10) in the simulation charts, I assume, and would be closer to reality.

Answer by SK Telecom :

Yes, (1/8,10) shows the result of the situation you said. In this case, some of other multipaths are aligned and the others are not aligned and the amounts of misalignment may be different. In the analysis, I only showed the best performance and from the simulation results we can expect the amount of degradation due to misalignment of other multipaths.

Question by LGIC

- It is assumed that the shape of multipath intensity profile (MIP) is a uniform. However, I think that the exponential MIP is more realistic. We can predict that USTS will have much performance gain in the expoenential MIP.

Answer by SK Telecom :

Uniform power delay profile is used because of its simplicity for mathematical analysis. The result equation for exponential profile is not a closed-form type. So I just showed the result for uniform profile.

My intention was to derive a simple equation to show:

1) the relation between SIR (Eb/Io) and capacity

2) impact of fast TPC

3) performance gain of USTS