TSG-RAN WG4 meeting #8 **TSGR4#8(99)642**
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Agenda item: **8.6**
Source: **Nokia**
Title: **Ec/Io on CPICH versus SIR on CPICH**
Document for: Decision

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1. Introduction

This document compares the measurement quantities Ec/Io = RSCP/RSSI and SIR=RSCP/ISCP measured on CPICH. The document provides performance comparisons and it also discusses implications to neighbour cell measurements in handover, cell selection and cell reselection evaluation due to the performance difference of these two measurement quantity. As a conclusion based on the results and discussion the document proposes that only the Ec/Io measurement on CPICH is used for handover, cell selection and cell reselection evaluation.

2. Performance comparison

In this chapter we compare the performances of Ec/Io=RSCP/RSSI and SIR=RSCP/ISCP measured on CPICH. As proposed in some discussions ISCP is estimated here using an orthogonal unused code, which is reserved for measurement purposes.

The probability density functions of RSSI and ISCP are compared in AWGN channel in Figure 1. The averaging period in this example is taken to be 4 symbols and Es/No in the channel is 7 dB. It can be seen from Figure 1 that RSSI estimation performs approximately 250 (almost the SF of CPICH) times better than ISCP estimation. Based on the formulas for the PDF of RSSI and the PDF of ISCP the performance difference stays almost independent of SNR and averaging length.

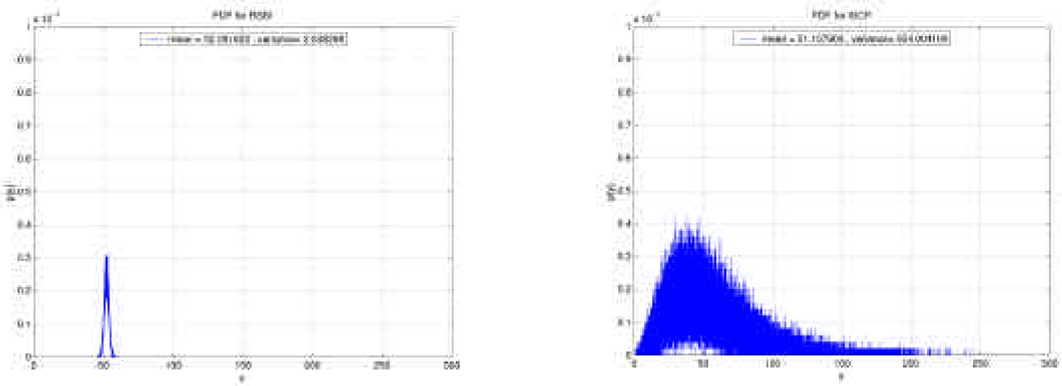

Figure 1. Comparison of the PDFs of RSSI and ISCP measurement quantities measured on CPICH in AWGN channel.

The PDF of RSCP in AWGN channel is presented in Figure 2. The averaging length is the same 4 symbols and Es/No 7 dB. The averaging for RSCP estimation is made coherently over 4 symbols in order to remove noise from the estimate. Figure 1and Figure 2 show that the performance of ISCP estimate is significantly worse than the performance of RSSI and RSCP estimates.

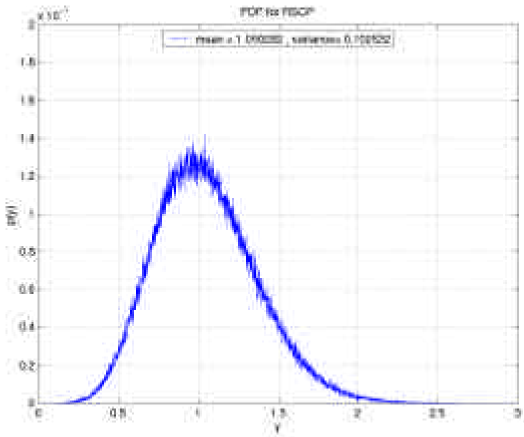

Figure 2. PDF of RSCP measured on CPICH in AWGN.

The PDF of Ec/Io is the joint probability density function of RSCP and RSSI and correspondingly the PDF of SIR is the joint probability function of RSCP and ISCP. In both of the measurements numerator is the same and only denominators differ from each other. Since the performance of the ISCP estimate is clearly worse than the performance of the RSSI estimate, the SIR is always worse than Ec/Io. However, the performance difference between RSCP/RSSI estimate and RSCP/ISCP estimates is not so straightforward the difference of denominators but the quality of RSCP estimate also influence the total estimation performance.

In Figure 3 the PDFs of Ec/Io=RSCP/RSSI and SIR=RSCP/ISCP are presented with the averaging length of 4 symbols and Es/No-level of 7dB. The averaging length is just an example value.

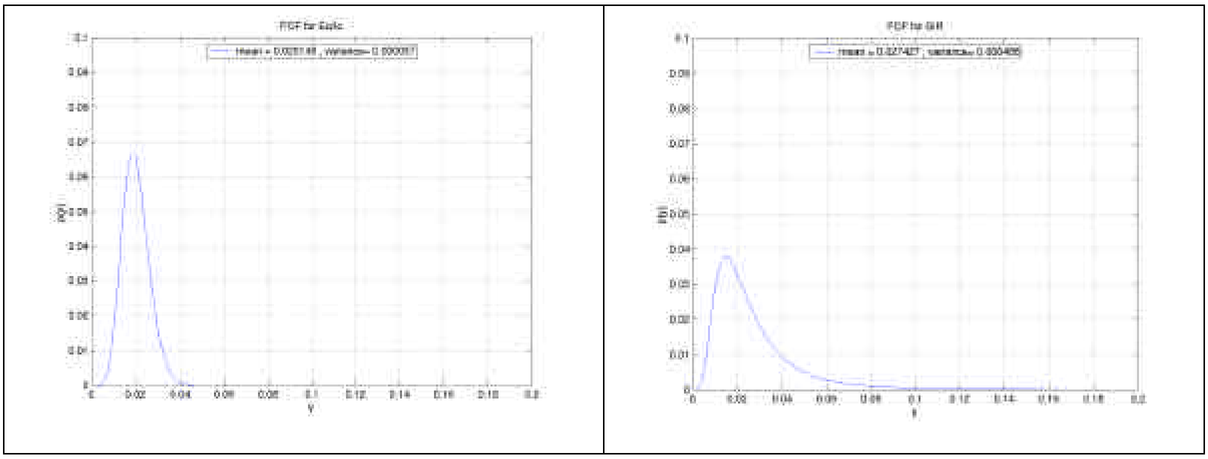

Figure 3. PDFs of Ec/Io and SIR in AWGN.

It can be seen from Figure 3 that the performance of SIR is significantly worse than the performance of Ec/Io. The variance of SIR is significantly higher than the variance of Ec/Io, the mean value of SIR is biased and the shape of the PDF curve of RSCP is influenced by the shape of the PDF curve of ISCP. These results shows that it is quite difficult to predict the performance of the SIR estimate since the performance of ISCP is so much worse than the performance of the RSCP.

RSCP, RSSI, ISCP, Ec/Io and SIR results for 1-tap Rayleigh fading channel with vehicle speed of 50km/h are presented in Appendix 6. Performance difference between RSSI and ISCP and further Ec/Io and SIR can clearly be seen also in this case.

An extra degradation, which is not taken into account in the analyses, occurs in the ISCP estimation if an ideal sampling point is not used for the estimation.

3. Conclusions

Based on the results shown in the previous chapter we can see that the performance of the ISCP estimation is almost spreading factor times worse than the performance of the RSSI estimation. This implies that the SIR measurement needs significantly longer averaging than the Ec/Io measurement. This naturally causes significant delay to the handover preparation process meaning that in case SIR on CPICH is used for the handover evaluation, the actual handover is delayed. On the other hand if the averaging period is not lengthened for the ISCP measurement, the probability of the correct evaluation of neighbour cell strengths becomes poorer and thereby unrealiable. In order to allow longer averaging without causing undesired delay to the handover preparation process, several parallel operations should be added to the UE. With this manner the measurement of several neighbours could be made fast and accurate enough but it would increase the complexity of the UE significantly. In [1] it was shown that even with the ideal SIR estimation, we cannot gain from using SIR on CPICH over Ec/Io on CPICH as a measurement quantity for handover evaluation. Thus we do not have any motivation to increase the UE complexity. So we do not see any reason in practice why SIR=RSCP/ISCP on CPICH should be added as a measurement quantity for handover evaluation.

4. Proposal

We propose that only Ec/Io=RSCP/RSSI on CPICH is used for handover, cell selection and cell reselection evaluation since in practice SIR=RSCP/ISCP does not bring any extra benefit to these processes.

5. References

[1] TSGR4#7(99)544; Is RSCP/ISCP needed for HO and cell selection purposes?

6. Appendix

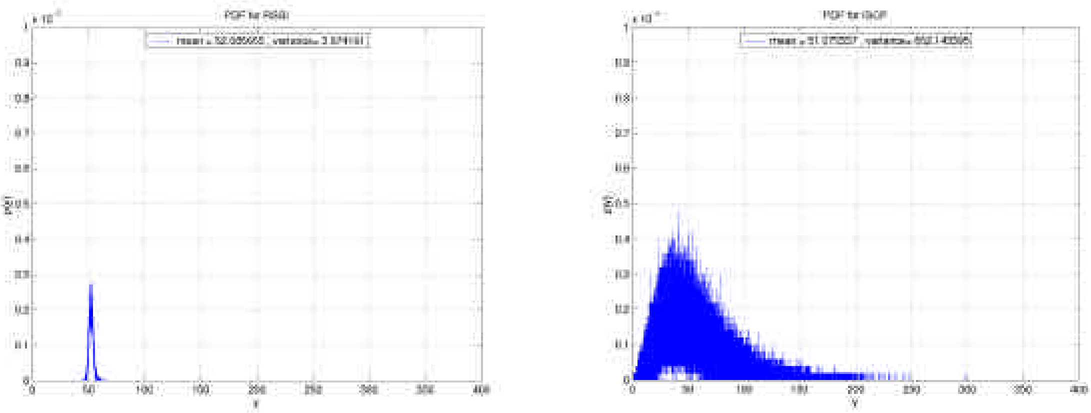

Figure 4 Comparison of the PDFs of RSSI and ISCP measurement quantities measured on CPICH in 1-tap Rayleigh fading channel, 50 km/h.

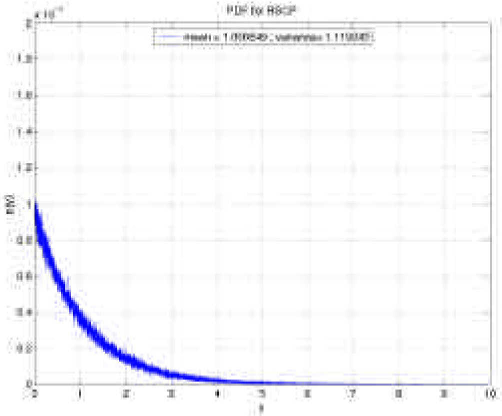

Figure 5 PDF of RSCP measured on CPICH in 1-tap Rayleigh fading channel, 50 km/h.

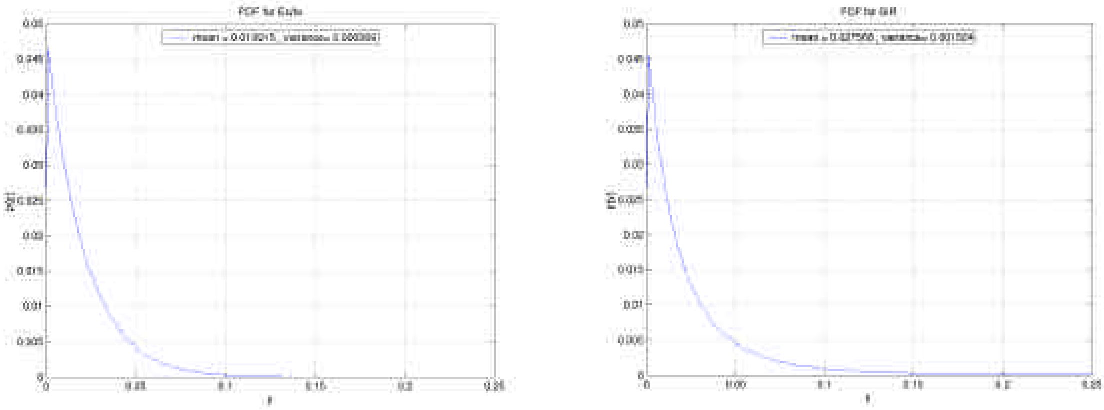

Figure 6 PDFs of Ec/Io and SIR in 1-tap Rayleigh fading channel, 50 km/h.