TSG-RAN meeting # 14 RP-010798
Kyoto, Japan
11-14 December, 2001

Status Report for WI to TSG

Work Item Name: Introduction of SIR measurement

SOURCE: Rapporteur **TSG:** RAN **WG:** 4

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Ref. to WI sheet: RAN_Study_Items.doc (originally in RP-010434)

Progress Report since the last TSG (for all involved WGs):

In the Stockholm RAN plenary meeting #12 in June 2001 the study item regarding "*Re-introduction of the downlink SIR measurement"* was approved. The Study Item completion date was set to September 2001 (RAN #13).
The reason behind the measurement is that a fast physical measurement is wanted, showing the received quality in the UE.

In the RAN WG4 meeting #18 in Berlin two contributions regarding this study item were presented,
- ✓ R4-010895: *Discussion on SIR measurement* by Ericsson and
- ✓ R4-011013: Consideration on the introduction of the SIR measurement in the downlink by TIM/ Telecom Italia Lab, Telefonica, Blu, One2One.

During RAN WG4 meting #19 in Edinburgh one further contribution was presented,
- ✓ R4-011203 *Discussion on the re-introduction of SIR measurement* by Nokia

During RAN #13 the completion date was postponed to RAN #14 and delegates (manufacturers) were encouraged to provide further contributions (on how to use existing measurements to solve the purpose) to the next WG4 meeting.

In the RAN WG4 #20, in New Jersey one contribution was presented,
- ✓ R4-011593, *Discussion on the SIR Measurement* by Ericsson

In this contribution the status of the study item was discussed and an alternative procedure using existing measurements was described for measuring the downlink quality. This alternative procedure does not take the orthogonality between the downlink channels into account.
This document is attached to this report.

This document was noted.

WI completion date review resulting from the discussion at the working group:

The conclusion at the RAN4#20 meeting was that it is proposed that the study item is closed.

TSG-RAN Working Group 4 (Radio) meeting # 20
East Brunswick, NJ, USA, 12-16 Nov, 2001

R4-011593

Agenda Item: 9.3

Source: Ericsson

Title: Discussion on the SIR Measurements

Document for: Discussion

Introduction

The SIR measurement on a dedicated channel has been discussed for some time. Operators have proposed the idea of introducing the measurement. It is claimed that the measurement has certain benefits compared with what is possible today.

Benefit 1: Estimation of Downlink coverage for a cell, e.g. performing a check on the FACH.

Benefit 2: Investigations on intracell interference, e.g. practical figure of loss of orthogonality factor in different types of cells.

Benefit 3: Investigations on intercell interference, e.g. refinement of planning parameters (e.g. antenna tilt) provided by the prediction tool (in-the-field validation).

Benefit 4: Distribution of perceived radio quality indication for a given service (or class of application). E.g. test of Downlinlk quality for the various users in a cell using a 64 kbps circuit-switch Radio Access Bearer. This is an extension of the Benefit 1.

Some concerns have been raised regarding the feasibility of the measurement. These concerns include the question on the definition of SIR, the inaccuracy of the measurement and the usage of the measurement.

In this document simulations of the SIR measurement are shown, an alternative procedure for measuring intra and inter cell interference is proposed. Finally, the advantages and disadvantages of the different approaches are given.

Simulations of the SIR Measurement

Ideal simulations of the absolute performance of SIR measurements on dedicated channels received on an AWGN channel have been performed with 1 slot and 300 slots (200ms) averaging. The results are shown in Figure 1.

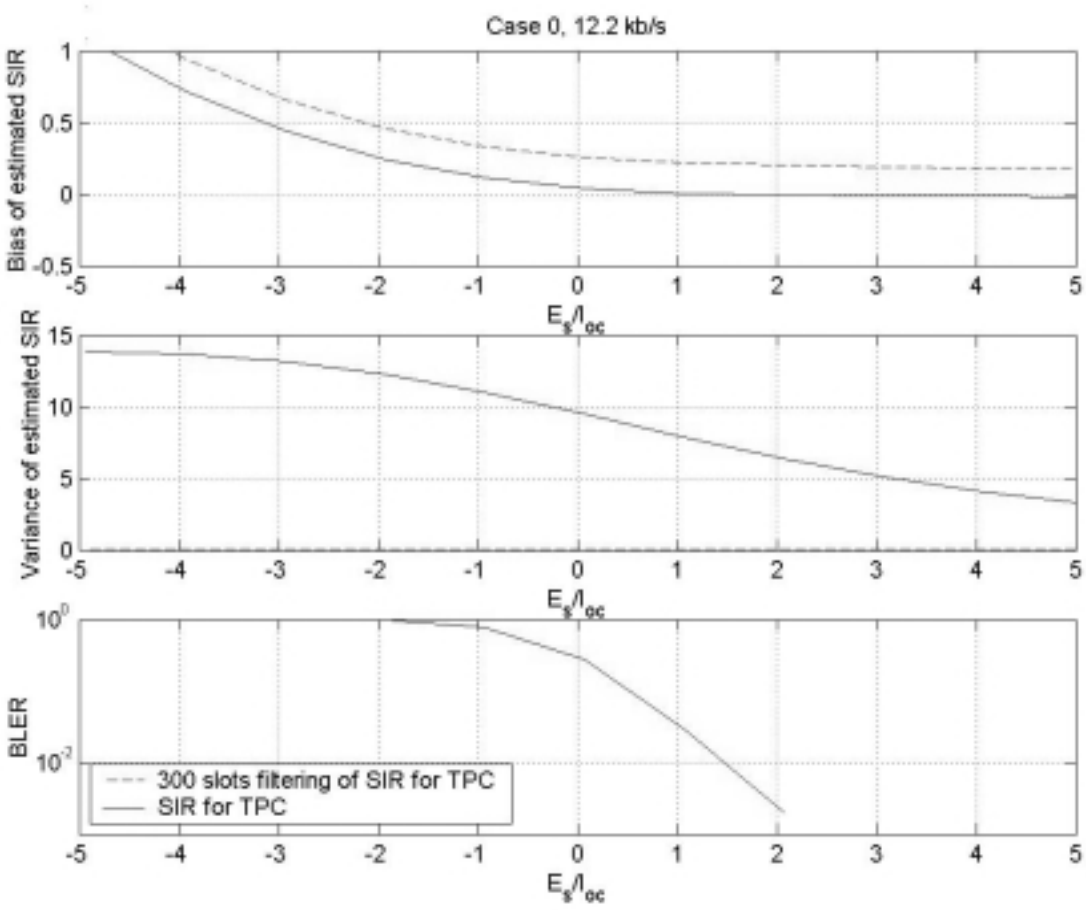

Figure 1 The received SIR level

For these simulations an AWGN channel is used. The intra-cell interference is for the one path propagation channel not interfering with the dedicated channel and is therefore not used as a parameter. The symbol energy, Es, is 10*log(SF)*Ec. For this 12.2 kbps testcase Ec = Es-24 dB

In these results it is seen that the performance of the measurement is degraded by the bias at low SIR levels but the variance of the measurement is always very small after averaging over 200 ms.

Alternative Measurements of intra and inter cell interference

Instead of having the UE measure the SIR level, the measurements already defined in the specifications can be used to get estimates of the geometry factor and the quality of the physical channels.

One example of how a procedure in the network may be performed is shown here. With measurements that are already defined the (Received Signal power)/(Inter_cell interference), (Received Signal power)/(Inter_cell interference) and the (Received Signal power)/(Total Intra_cell interference) can be calculated per radio link.

$$\frac{\textbf{\textit{Recevied dedicated code power}}}{\textbf{\textit{Total ínterference}}} = \frac{DPCH\_Ec}{Io} =$$

$$= \frac{Transmitted\ Code\ Power}{\mathrm{Pr}imary\ CPICH\ Power} \times \mathrm{Re}ceived\ CPICH\_E_c / I_o\big|_{Rx}$$

$$\frac{\textbf{\textit{Recevied dedicated code power}}}{\textbf{\textit{Inter-cell ínterferen ce}}} = \frac{DPCH\_Ec}{Io - Ior} =$$

$$= \frac{Transmitte\ d\ Code\ Power}{\mathrm{Pr}imary\ CPICH\ Power} \times \frac{1}{\frac{1}{\mathrm{Re}ceived\ CPICH\_E_c / I_o\big|_{Rx}} - \frac{Transmitte\ d\ Carrier\ Power}{\mathrm{Pr}imary\ CPICH\ Power}}$$

and

$$\frac{\textbf{\textit{Recevied dedicated code power}}}{\textbf{\textit{Intra-cell ínterference}}} = \frac{Transmitted\ Code\ Power}{Transmitted\ Carrier\ Power}$$

The variables used in the equations above are two UTRAN measurements, **Transmitted Carrier Power and Transmitted Code Power**, one UTRAN parameter, **`Primary CPICH Power`,** and the UE measurement **Received CPICH_Ec/Io.**

In these measurements the Intra-cell interference means the total received power from the cell and does thereby not include the orthogonality factor. Instead it shows how much of the total capacity of that cell that is used for one certain dedicated channel.

Using these parameters the terminal only need to report the already defined Received CPICH_Ec/Io to calculate the ratio of dedicated power and Inter-cell interference. Furthermore the ratio of the dedicated power and the Intra-cell interference is already known in the network without any reports from the UE.

The estimations in the example above are calculated per radio link. The previous UE SIR measurement was defined after RL combination, and therefore they are not comparable in that sense.

Comparison of performance

AWGN channel

For the alternative procedure the following accuracies are specified:

Transmitted Carrier Power: +/- 5% units

Transmitted Code Power: +/- 3dB

Received CPICH_Ec/Io: +/- 1.5 - +/- 3 dB on an AWGN channel.

Assuming the accuracy of the transmitted CPICH power is much better than 3 dB, the total accuracy of this procedure is in the worst case in the range of +/- 3 dB for an AWGN channel.

For a SIR measurement, the inaccuracy of an ideal measurement seems to be very small. However with implementation degradation the inaccuracy will increase at least to a couple of dBs.

Therefore our conclusion is that the performance is similar for the two cases.

Fading and Multipath channels

For a fading channel, the received CPICH_Ec/Io measurement will be degraded, how much depends on the propagation conditions. However, usually the CPICH power is reasonably high and L1 filtering is applied on this measurement.

For the SIR measurement the problems are more severe since the SIR is currently not defined for a multipath channel. Unless the SIR measurement is defined for a multipath channel there is a risk that different UEs will not behave in the same way and therefore the inaccuracy will increase both because different implementations will behave differently and because the acual measurement is degraded due to the fading. However if the SIR estimate for TPC estimation is used for the measurement, the L1 averaging is really good.

Conclusion

Two different approaches for measuring the received quality of a dedicated channel have been compared. One approach is that a new measurement is defined to perform SIR measurements after RL combination and another approach is to use existing measurements in the UE and the Network.

The first part of the document proves that the SIR measurement is feasible to perform on dedicated channels. With this measurement the real interference level of the received combined signal from the active set is measured, including the orthogonality factor.

The alternative solutions using the measurements already present in the standard were considered; the solutions presented in the document give an estimation of the received power from the cells other than the measured radiolink, and they give an estimation of the inter-cell interference as well as the received power from the actual radiolink. However in this measurement the orthogonality-factor is not included.

The measurement accuracies of the two approaches are similar on an AWGN channel while on fading multipath channels the SIR must be well defined before the accuracy can be estimated. For the CPICH_Ec/Io measurement it is easier to generalise the definition to multipath channels.

Evaluating the benefits given in the introduction:

For benefit 1, estimation of downlink coverage for a cell, the SIR measurement will not be performed on a FACH while the alternative approach can be used. On a dedicated channel the orthogonality factor is taken into account measuring what quality is received. The alternative approach instead measure how large the inter-cell interference is and how much power, in relation to the total power budget, the dedicated channel needs to give the required quality.

For benefit 2, investigations on intracell interference, the SIR measurement take the orthogonality-factor into account but it does not separate the inter and intra cell interference which the alternative approach does.

For benefit 3, investigations on intercell interference, The SIR measurement does not separate the inter cell interference from the total interference while the alternative approach does.

For benefit 4, perceived radio quality indication for a given service, the SIR measurement gives the quality of the received signal, relevant for the quality after decoding, from the active set. The alternative approach does not take the orthogonality-factor into account.

Now in WG4 it has to be considered whether it is essential to have the a SIR measurement, with the information of the orthogonality that is inherent in that measurement, or if the measurements already existing give the information required in this study item. A conclusion on the study item must be given at the next RAN meeting in december.

We propose that if measurements on the geometry factor and fast physical channel quality measurements are required, algorithms similar to the alternative proposal here should be used in the networkThe terminals should not be required to perform the SIR measurement and report if similar information is already known in the network. Therefore we currently do not see any need to specify a SIR measurement in the UE unless it is shown that a real SIR value including the orthogonality factor is useful in the network.

References

R4-011203 Discussion of the re-introduction of SIR measurement, Nokia

R4-010647 Re-introduction of transport channel SIR measurement, TIM/TILAB, Blu, Mobilkom Austria,

R4-010895 Discussion on the SIR measurement, Ericsson