TSG-RAN Working Group1 meeting #4
Yokohama 19-20, April 1999

**TSGR1#4(99)363**

|  |  |  |
|---|---|---|
| **Agenda Item** | **:** |  |
| **Source** | **:** | Nokia |
| **Title** | **:** | A new reliability factor for TPC command in soft handover |
| **Document for** | **:** | Discussion |

---

**Summary:**

In this document, the performance results of a new reliability factor for TPC in soft handover are presented. The new reliability factor is based on TPC soft symbols instead of SIR-value. The achieved results clearly indicate that the proposed method can offer better performance compared to the SIR-based scheme. Therefore we propose the TPC soft symbols for the reliability factor in the soft handover, as a replacement for the SIR-based scheme.

## 1. INTRODUCTION

According to the current 3GPP specification UE combines the received power control commands into a single TPC command. The combination scheme is dependent on whether the received TPC commands are known to be same or not. In the case of soft handover, the power control commands transmitted in the different cells may be different. It is specified in 5.1.2.2.3.1 [1] that firstly the terminal shall estimate the signal-to-interference ratio PC_SIR$_i$ for each received power control command TPC$_i$. Secondly, the terminal assigns to each of the TPC$_i$ command a reliability figure W$_i$, where W$_i$ is a function of PC_SIR$_i$. Finally, the terminal derives a combined power control command as a function of all power control commands and reliability estimates. Reliability figure W$_i$ can take the values 0 or 1 based on the PC_thr comparison result.

This paper proposes a new method of retrieving the reliability of a TPC command from the TPC soft symbols instead of SIR. Furthermore, the performance of the proposed method can be enhanced by introducing MRC and/or soft symbol integration as a parallel TPC command treatments in SHO.

## 2. DESCRIPTION OF THE PROPOSED METHOD

The proposed scheme can be divided into three parts, which are depicted below.

### Part I:

The reliability estimation of the basic algorithm can be enhanced by using a soft symbol parameter instead of SIR for this purpose. The algorithm is defined as follows:

```
IF $TPC\_input1\_command \geq soft\_symbol\_threshold$
        $TPC\_output1\_command = 1$
ELSE
        $TPC\_output1\_command = 0$
END
```

If there are two BTS, i.e. two individual TPC commands, the minimum command is selected. Therefore, even one down-command results in the MS decreasing power.

The range for *soft_symbol_threshold* used in simulations is from –0.6 to 0.0, where an optimum performance is usually obtained with a -0.25 to -0.30 value.

### Part II:

Even if the sensitivity of the reliability threshold is already improved by the soft symbol reliability estimation, this can be further enhanced by modifying the power control algorithm by introducing Maximum Ratio Combining (MRC). The threshold for MRC is set to 0. The original algorithm with soft symbol reliability estimation and the MRC algorithm are run in parallel. The minimum value of these two is the output of the total power control algorithm.

**Part III:**

The algorithm can be even further enhanced by the use of an integrating component, in addition to the MRC component. As in the previous case, these are run in parallel and the minimum individual output determines the final output.

In this approach, the minimum input soft symbols are integrated and a separate soft symbol thresholding for this integrated sum is conducted. After each TPC round, the minimum soft symbol value of that round is added to the integrated sum. If the integrated sum exceeds a predetermined threshold, a power-down command is issued, even if the individual soft symbols from that particular TPC round do not imply a power-down command.

If a power-down command is issued, based on the integrated sum exceeding its threshold value or the individual soft symbols, the integrated sum for the next TPC round is again set to zero.

The main benefit of this approach is that it adds "memory" to the system.

## 3. MAIN RESULTS

The performance of the proposed method was studied within an accurate WCDMA radio link simulation tool. The Pedestrian_A channel model with different mobile speeds has been used in the simulations.

Figure 1(a) depicts the results for the transmitted power Ptx in uplink for 3 km/h and UL/DL FER 1%, as a function of the reliability thresholds employed (SIR or soft symbol, depending on algorithm). In addition, a similar graph when UL/DL FER is 10% is shown in Figure 1(b). According to the simulation results the minimum Ptx with the new algorithms is roughly 0.5 dB less than with the SIR-based algorithm at 1% FER level. Furthermore, the parameter sensitivity seems to be clearly higher for the SIR-based algorithm, where an "out-of-range" SIR threshold easily ruins the algorithm performance. Especially, the soft symbol + MRC and the soft symbol + MRC + Integration based algorithms yields a Ptx behavior that is only slightly dependent on the reliability threshold when the threshold ranges from –0.6 to –0.15. The results for 10% FER are similar, although the difference in the minimum Ptx levels is slightly smaller.

Figure 2(a) and (b) shows the behavior of the transmitted power Ptx as a function of mobile speed (3, 20, 50 and 120 km/h) for UL/DL FER of 1% and 10%, respectively. The results indicate that the transmitted power levels in UL are clearly smaller for all speeds with all of the new algorithms when compared to the SIR-based algorithm. On the one hand the minimum Ptx levels are obtained with the soft symbol + MRC + Integration based algorithm, but on the other hand differences to the other two new approaches are negligible, except in 120 km/h 1% FER case. Thus, the soft symbol algorithm shows roughly 0.4 dB higher Ptx levels than the other two new algorithms.

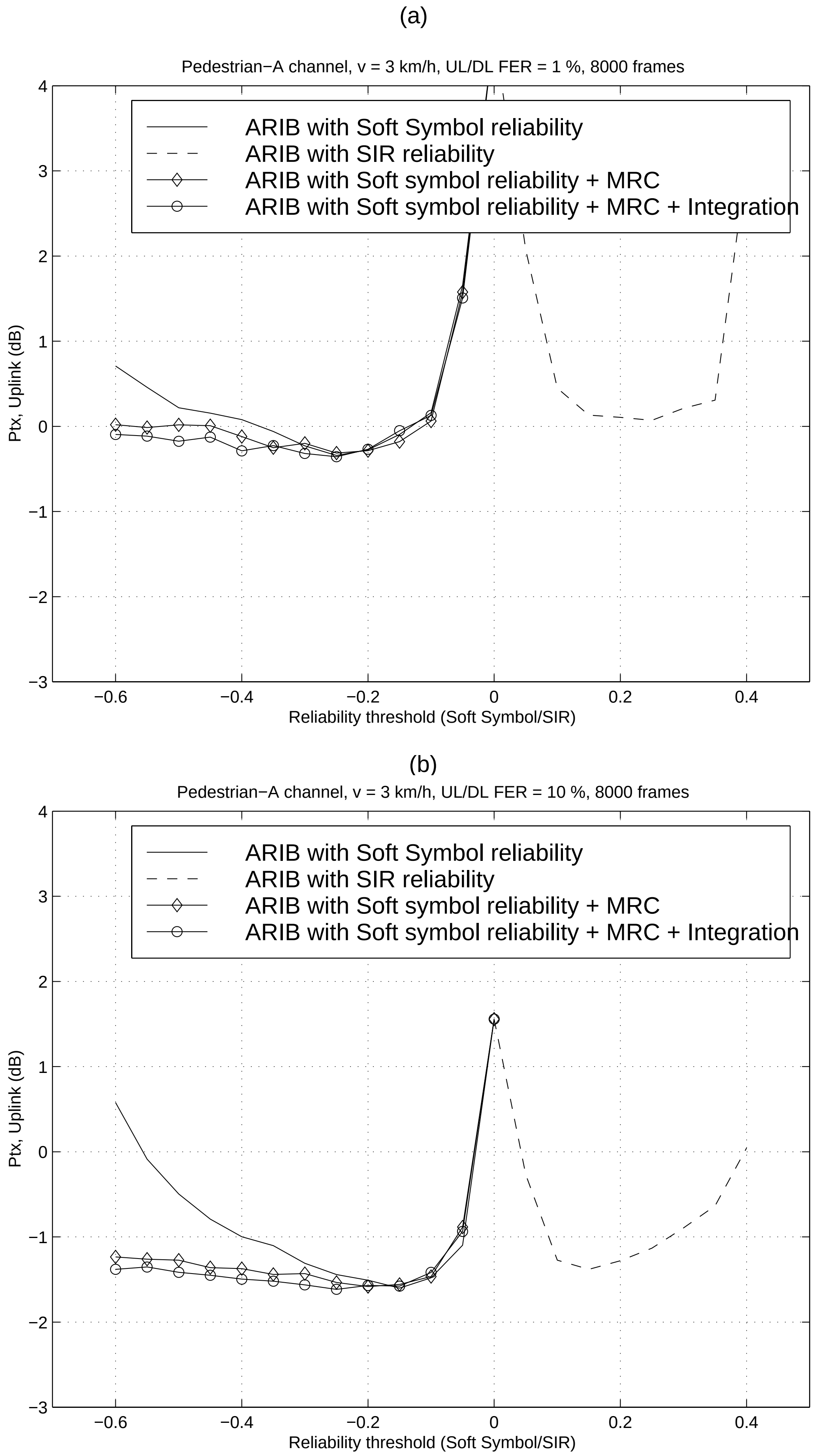

**Figure 1. Comparison of transmitted uplink power (in dB) when mobile speed is 3 km/h and UL/DL FER is (a) 1% and (b) 10%.**

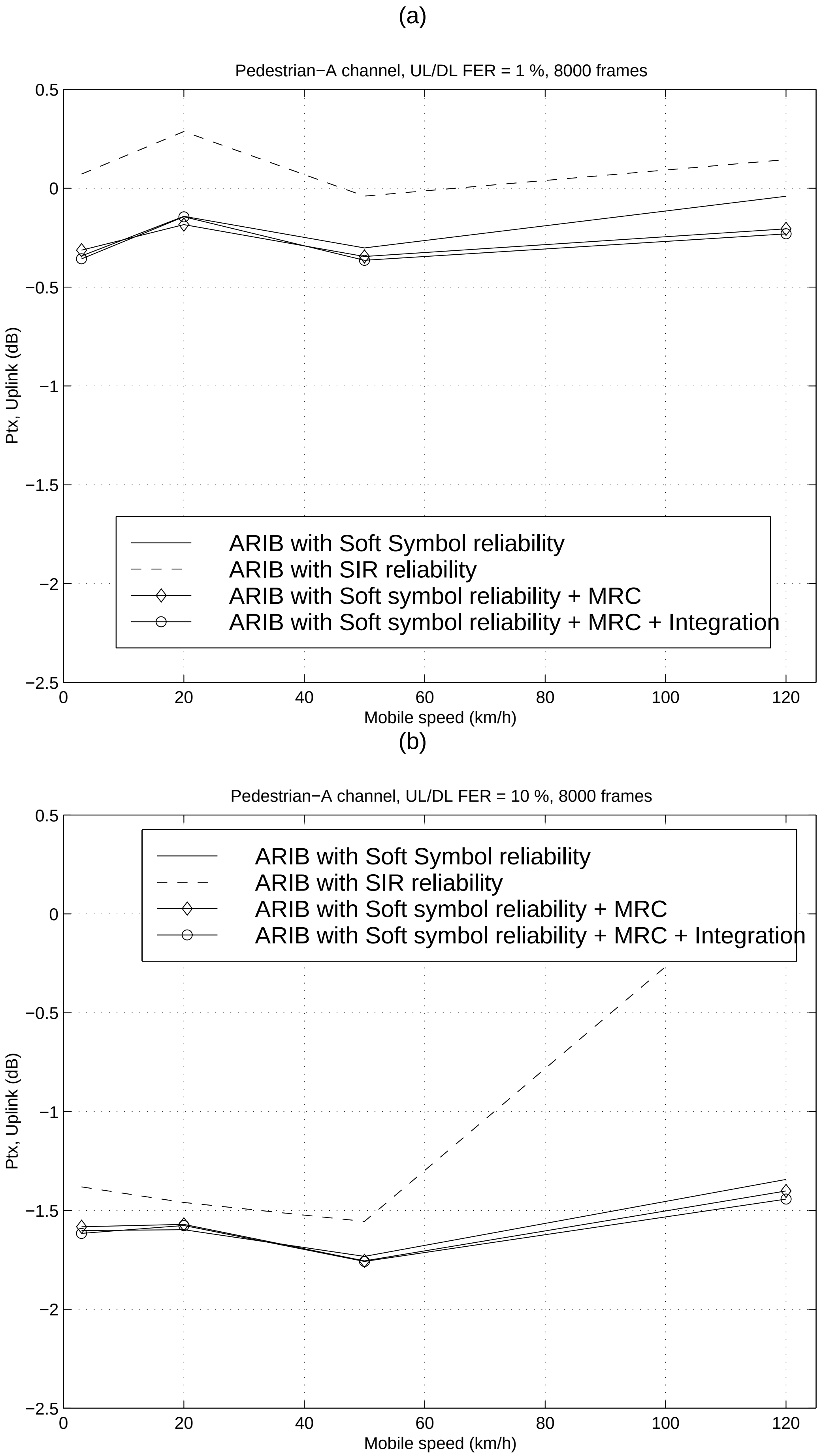

**Figure 2. Comparison of transmitted uplink power (in dB) as a function of mobile speed (km/h). The UL/DL FER is (a) 1% and (b) 10%.**

## 4. CONCLUSION

In this document, the performance results of a new reliability factor for TPC in soft handover are presented. The new reliability factor is based on TPC soft symbols instead of SIR-value. Furthermore, the proposed schemes performance can be enhanced by using MRC and/or soft symbol integration as parallel TPC command treatments in SHO. The achieved results clearly indicate that the proposed method can offer better performance compared to the SIR-based scheme. Consequently, in the pedestrian_A channel model with mobile speed of 3 km/h the transmitted power Ptx is roughly 0.5 dB less than with the SIR-based method. In addition, the SIR-based scheme seems to be quite vulnerable to reliability threshold parameters sensitivity whereas soft symbol + MRC + Integration is only slightly dependent on the reliability threshold. Therefore we propose the TPC soft symbols for the reliability factor in the soft handover, as a replacement for the SIR-based scheme in document S1.14.

## REFERENCES

[1] 3GPP RAN S1.14 Physical layer procedures v1.0.1 (1999-03)

## TEXT PROPOSAL FOR S1.14, SECTION 5.1.2.2.3

### 5.1.2.2.3 Combining of TPC commands not known to be the same

In general in case of soft handover, the TPC commands transmitted in the different cells may be different.

This subclause describes the general scheme for combination of the TPC commands known to be different and then provides an example of such scheme. It is to be further decided what should be subject to detailed standardisation, depending on final requirements. The example might be considered as the scheme from which minimum requirement will be derived or may become the mandatory algorithm.

### 5.1.2.2.3.1 General scheme

First, the UE shall conduct the soft symbol decision on each of the power control command $TPC_i$, where i = 1, 2, …, N and N is the number of TPC commands known to be different, that may be the results of a first phase of combination according to subclause 5.1.2.2.3.

Then the sensitivity of the soft symbol reliability threshold is improved by Maximum Ratio Combining (MRC) and integrating component. These are run in parallel with soft symbol reliability estimation and the minimum individual output determines the final output.

In this approach, the minimum input soft symbols are integrated and a separate soft symbol thresholding for this integrated sum is conducted. After each TPC round, the minimum soft symbol value of that round is added to the integrated sum. If the integrated sum exceeds a predetermined threshold, a power-down command is issued, even if the individual soft symbols from that particular TPC round do not imply a power-down command.

If a power-down command is issued, based on the integrated sum exceeding its threshold value or the individual soft symbols, the integrated sum for the next TPC round is again set to zero.

~~Then the UE assigns to each of the $TPC_i$ command a reliability figure $W_i$, where $W_i$ is a function β of $PC\_SIR_i$, $W_i = \beta(PC\_SIR_i)$. Finally, the UE derives a combined TPC command, TPC_cmd, as a function γ of all the N power control commands $TPC_i$ and reliability estimates $W_i$:~~

~~$TPC\_cmd = \gamma\,(W_1, W_2, \ldots W_N, TPC_1, TPC_2, \ldots, TPC_N)$, where TPC_cmd can take the values 0 or 1.~~

### ~~5.1.2.2.3.2 Example of the scheme~~

~~A particular example of the scheme is obtained when using the following definition of the functions β and γ:~~
~~**For β:** the reliability figure $W_i$ is set to 0 if $PC\_SIR_i < PC\_thr$, otherwise $W_i$ is set to 1. This means that the power control command is assumed unreliable if the signal-to-interference ratio of the TPC commands is lower than a minimum value PC_thr.~~

~~**For γ:** if there is at least one $TPC_i$ command, for which $W_i = 1$ and $TPC_i = 0$, then TPC_cmd is set to 0, otherwise TPC_cmd is set to 1. Such a function γ means that the power is decreased if at least one cell for which the reliability criterion is satisfied asks for a power decrease.~~