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| **Agenda item:** | **7. Ad Hoc: Tx diversity** |
| **Source:** | **Siemens AG** |
| **Title:** | **STTD coding method using up to four antennas to improve the performance of Indicator Channels (PICH)** |
| **Document for:** | **Discussion** |

## 1. Introduction

There is a Study Item dealing with radio link performance enhancements, and under this Study Item WG1 has set up an Ad Hoc dealing with TX-Diversity enhancements using 4 antennas. Up to now only closed-loop techniques have been investigated. According to these contributions it will be an option in Release 2000 to operate with more than 2 Tx antennas in closed-loop mode. However, it should be investigated if the presence of more than 2 antennas at the cell site (which are assumed in this contribution to have been deployed to support closed-loop techniques) can be used also for an extension of open-loop Tx diversity techniques. As the added complexity mainly comes from the additional antennas and the associated amplifiers and digital parts, adding an open-loop scheme comes at almost no incremental cost.

There are some mathematical limitations for a block STTD coding scheme for more than 2 Tx antennas. In fact, general optimum STTD codes only exist for 2 Antennas.

With this paper an STTD coding scheme for up to 4 antennas is presented that can be applied to all the Indicator Channels (PICH, AICH, AP-AICH, CD/CA-ICH and CSICH). Simulations show that a diversity gain of about 2.1 dB at 1% raw error rate can be expected compared to 2 antenna STTD encoding.

As a constraint the problem of backward compatibility must me considered. This is mostly left for further discussion and further investigation, since many issues of Release 2000 are not finalized yet. The usage of the proposed coding scheme is easiest applicable to the PICH.

## 2. Proposed STTD coding scheme for up to 4 antennas

The proposed STTD coding scheme for 4 antennas is described in the same way as the STTD scheme for 2 antennas in TS 25.211:



STTD encoded channel bits
for antennas 1 to 4
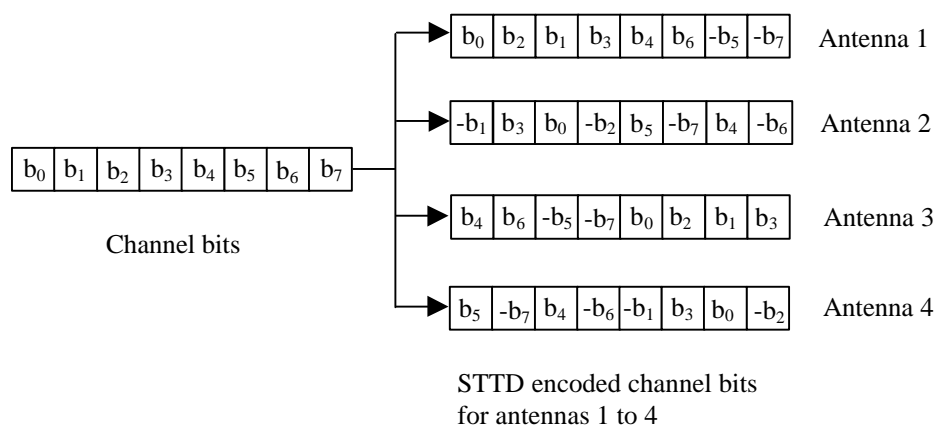
Note, that for the Indicator Channels the channel bits have the following property:
$b_{2i} = b_{2i+1}$

While there does not exist an optimum general STTD encoding scheme for 4 antennas, the above mentioned coding is optimum, if $b_{2i} = b_{2i+1}$ i.e. in particular for indicator type channels.

For the usage of 3 antennas one can simply omit the transmission on antenna 4.

## 3. Simulation Results

Figure 1 shows a comparison between open-loop Tx diversity using 2 antennas and 4 antennas for the PICH. A 1 tap Rayleigh fading channel was assumed at vehicle speed of 30 km/h and carrier frequency 2 GHz. Also, ideal channel estimation was assumed. The number of PI per frame was chosen to be N = 144.
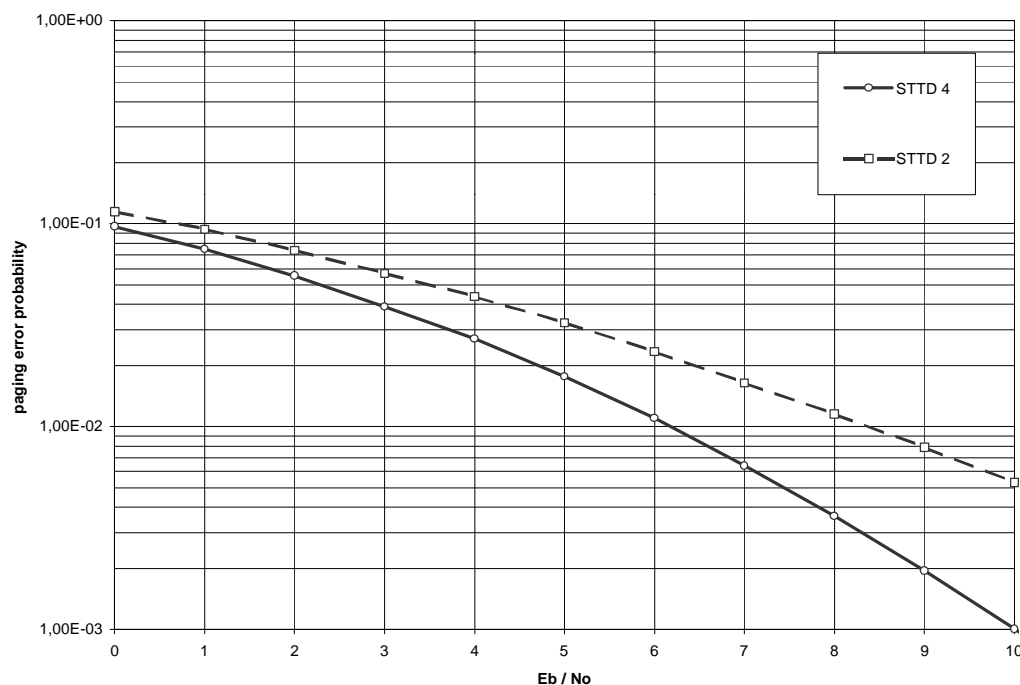


**Figure 1: Comparison between STTD schemes with 2 and 4 antennas for PICH**

The simulation shows an improvement in paging error probability of about 1 dB at 10% failure rate and a gain of 2.1 dB at 1% failure rate. This equals to the maximum achievable gain using open-loop Tx diversity with 4 antennas.

## 4. Compatibility issues

When the base station is using 4 antennas for the PICH (open-loop diversity), the mobile must be of Release 2000 (or higher). Thus, the base station can only page higher than Release 99 mobiles with the proposed scheme. In addition the cell site must indicate the number of antennas (1, 2, 3 or 4) it is using for STTD encoding in the BCH. To avoid a conflict with Release 99 mobiles a separate PICH ("secondary" PICH) using a different scrambling or channelisation code is suggested. Other solutions may be possible and are welcome to be discussed.

For the other Indicator Channels (AICH, AP-AICH, CD/CA-ICH, CSICH) the performance improvement would be the same. The open question is that at the cell site it may not be known if the mobile is of Release 99 or 2000.

## 5. Conclusions

A new STTD coding scheme for up to 4 antennas was presented for the "Indicator Channels". Applied to a the PICH the coding scheme would achieve a gain of about 2.1 dB to the paging error rate. The same gain would be achieved to the other "Indicator Channels" if the base station knows whether the mobile is of Release 99 or 2000. In addition, investigations are still needed to check if STTD schemes with more than 2 antennas can be applied to some other Physical Channels.