Agenda Item: Rel'4 CRs

Document for: Decisions

Source: Nokia

Application of beamforming and combinations of beamforming with TX-diversity in UTRA FDD downlink

Introduction

This paper presents the clarifications for TS 25.211 for the application of the beamforming (e.g. adaptive antenna methods) for the UTRA FDD downlink channels as a response to the LS received fro m WG4. It is proposed that this CR would be approved to Rel'4 specifications and would be provided as an LS to other WGs or alternatively clearly reported as part of TSG RAN WG1 report in the TSG RAN#11. There is not expected to be much room for misunderstanding with the aspects mentioned based on the past discussions in WG1, but as mentioned by WG4 there might be later room for different interpretation since information is being scattered in different specifications currently. Thus proposed clarifications would prevent problems in the future.

Summary of the proposed changes

The first clarification is to include a clear table which shows similar to the TX diversity which channels may use downlink beamforming.

For the closed loop methods it is clarified that they are not applicable to be used with beamforming without S-CPICH based on their usage of CPICH for the estimation on which to base the feedback commands in the uplink, as explained in 25.214.

For the open loop methods it is also stated in 25.211 (5.3.3.1) that CPICH shall be transmitted from both antennas, thus STTD should not be used with beamformig if there is no S-CPICH available in the beam.

For the PDSCH is it clarified that the same beam needs to be used as there is no information on PDSCH for the phase estimation.

For the S-CCPCH it is clarified that beamforming without CPICH is not applicable at all. (The performance for doing all the necessary estimations by the UE from a single S-CCPCH frame would not be necessary very good either). The use of S-CPICH is retained thought from the discussion it was understood that current architecture can not use any kind of beamforming on FACH.

In the discussion it was also noted that what is meant with beamforming is defined by the relevant test cases in WG4 Rel'4 specifications, thus this CR is made for Rel'4 specifications only.

The proposed CR to TS 25.211 is attached.

Recommendation

It is recommend to introduce the attached CR to TS 25.211. Further work in this area should be done in co-operation with WG4 to have suitable test cases for the coming releases on the related matters.

From TS 25.331 it can be seen that the signalling is done in a generic way i.e. not specific to any transport/physical channel and there is no need for updates on the RRC specification. Thus there is no need for accompanyig CR for TS 25.331 on this issue.

CR-Form-v3

CHANGE REQUEST

✆ **25.211** CR **093** ✆ rev **1** ✆ Current version: **3.5.0** ✆

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ✆ symbols.*

Proposed change affects: ✆ (U)SIM ☐ ME/UE **X** Radio Access Network **X** Core Network ☐

Title:	✆	Application of beamforming and combination of beamforming with TX-diversity on UTRA FDD downlink
Source:	✆	Nokia
Work item code: ✆		***Date:*** ✆ 27.01.2001
Category:	✆ **F**	***Release:*** ✆ Rel-4

Use one of the following categories:
 F *(essential correction)*
 A *(corresponds to a correction in an earlier release)*
 B *(Addition of feature),*
 C *(Functional modification of feature)*
 D *(Editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:
 2 (GSM Phase 2)
 R96 (Release 1996)
 R97 (Release 1997)
 R98 (Release 1998)
 R99 (Release 1999)
 REL-4 (Release 4)
 REL-5 (Release 5)

Reason for change:	✆	The applicability of beamforming and combinations of beamforming and TX diversity is not currently covered in the TSG RAN WG1 specifications
Summary of change:	✆	The table listing the downlink physical channels that may use beamforming (e.g. adaptive antennas) and the combinations of the beamforming and TX-diversity methods has been added based on the feedback received from TSG RAN WG4.
Consequences if not approved:	✆	Potential misinterpretation may cause interoperability problems between UE and UTRAN when using beamforming or when using both TX-diversity and beamforming

Clauses affected:	✆	5.3.1
Other specs affected:	✆ ☐ ☐ ☐	Other core specifications ✆ Test specifications O&M Specifications
Other comments:	✆	

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

5.3   Downlink physical channels

5.3.1   Downlink transmit diversity and beamforming

Table 10 summarizes the possible application of open and closed loop transmit diversity modes on different downlink physical channel types. Simultaneous use of ~~STTD~~ open and closed loop modes on the same physical channel is not allowed. In addition, if Tx diversity is applied on any of the downlink physical channels it shall also be applied on P-CCPCH and SCH. Regarding CPICH transmission in case of transmit diversity, see subclause 5.3.3.1. For possible application of beamforming simultaneously with transmit diversity on different downlink channel types, see subclause 5.3.1.3 for both open and closed loop mode methods.

Furthermore, the transmit diversity mode used for a PDSCH frame shall be the same as the transmit diversity mode used for the DPCH associated with this PDSCH frame. During the duration of the PDSCH frame, and within the slot prior to the PDSCH frame, the transmit diversity mode (open loop or closed loop) on the associated DPCH may not change. However, changing from closed loop mode 1 to mode 2 or vice versa, is allowed.

Table 10: Application of Tx diversity modes on downlink physical channel types
"X" – can be applied, "–" – not applied

Physical channel type	Open loop mode		Closed loop Mode
	TSTD	STTD	
P-CCPCH	–	X	–
SCH	X	–	–
S-CCPCH	–	X	–
DPCH	–	X	X
PICH	–	X	–
PDSCH	–	X	X
AICH	–	X	–
CSICH	–	X	–

5.3.1.1   Open loop transmit diversity

5.3.1.1.1   Space time block coding based transmit antenna diversity (STTD)

The open loop downlink transmit diversity employs a space time block coding based transmit diversity (STTD). The STTD encoding is optional in UTRAN. STTD support is mandatory at the UE. STTD encoding is applied on blocks of 4 consecutive channel bits. A block diagram of a generic STTD encoder for channel bits b_0, b_1, b_2, b_3 is shown in the figure 8 below. Channel coding, rate matching and interleaving is done as in the non-diversity mode. The bit b_i is real valued {0} for DTX bits and {1, -1} for all other channel bits.
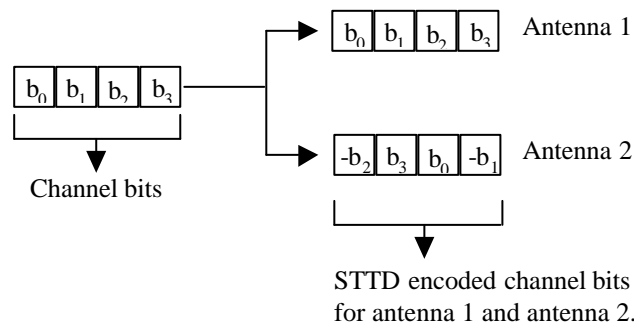
Figure 8: Generic block diagram of the STTD encoder

5.3.1.1.2   Time Switched Transmit Diversity for SCH (TSTD)

Transmit diversity, in the form of Time Switched Transmit Diversity (TSTD), can be applied to the SCH. TSTD for the SCH is optional in UTRAN, while TSTD support is mandatory in the UE. TSTD for the SCH is described in subclause 5.3.3.4.1.

5.3.1.2   Closed loop transmit diversity

Closed loop transmit diversity is described in [5]. Both closed loop transmit diversity modes shall be supported at the UE and may be supported in the UTRAN.

5.3.1.3 Downlink Beamforming

Table 11 summarizes the possible application of beamforming with and without S-CPICH present in the same beam on different downlink physical channel types.

Table 11: Application of beamforming concepts on downlink physical channel types
"X" – can be applied, "−" – not applied

Physical channel type	Beamforming with S-CPICH	Beamforming without S-CPICH
P-CCPCH	–	–
SCH	–	–
S-CCPCH carrying PCH	-	-
S-CCPCH carrying FACH only	X	-
DPCH	X	X
PICH	–	–
PDSCH*	X	X
AICH	–	–
CSICH	–	–

Note *   Associated DPCH shall be transmitted in athe same beam

Table 12 summarizes the possible application of silmultaneous use of beamforming and TX diversity with both open loop or closed loop TX diversity methods in [5] on a downlink physical channel. Note that only the channels that support the use of downlink beamforming as indicated in Table 11 have been included in Table 12. The restrictions in Table 12 are valid only for a channel using beamforming. There needs to be always S-CPICH (with diversity pilot) used in the same beam if it is desired to use both beamforming and TX diversity simultaneously on a downlink physical channel.

Table 12: Application of Tx diversity modes on a downlink physical channel using beamforming,
"X" – can be applied, "−" – not applied

Physical channel type used	Open loop mode & beamforming with S-CPICH	Closed loop mode & beamforming with S-CPICH
S-CCPCH carrying FACH only	X	-
DPCH	X	X
PDSCH*	X	X

Note* Associated DPCH shall be transmitted in the same beam