

Title: Flexible CL TX Diversity Timing
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Introduction

During TSG RAN1#29 in Shanghai a CR was proposed for approval in release 99. The CR proposed to state that a UE using closed loop transmit diversity shall be capable of supporting different settings of the closed loop timing adjustment mode on different radio links of the active set.

Motorola's view at RAN1 meeting was that this CR adds a new functional requirement to the UE with potential implications on UE implementation. Therefore, we could not accept the CR for release 99 or release 4, but we were prepared to accept the CR in release 5. Companies at RAN1 agreed that the new requirement should not be added to release 99 but some companies felt that it should be added to release 4. This was not acceptable to Motorola.

Limited Consequences

Currently the RAN1 specification do not state whether the UE needs to handle different settings of the closed loop timing adjustment mode on different radio links of the active set. The RRC signalling does permit different timing modes for different radio links to be signalled to the UE.

Given that the RAN1 specifications do not specify the UE behaviour, the cautious approach would be for the network to not apply different timing modes to different radio links. This could mean that the network would have to apply the worst case timing adjustment mode (J+2) to all cells that support transmit diversity and that are likely to be part of the same active set. The impact of using timing adjustment mode J+2 is that the performance benefit of closed loop transmit diversity will fall off at a lower UE speed than when using timing adjustment mode J+1.

However, if the network were to apply different timing modes to different radio links and signal this to the UE, then the UE would apply one of the two possible timing modes to all of the radio links in the active set. Hence some radio links would not have the correct timing mode applied. This will cause some degradation to the link performance in some radio environments.

Without providing detailed simulation results it is still possible to comment on the likely degradation. At low speed when the channel is not changing rapidly the closed loop antenna weights will not be changing rapidly and the degradation is not likely to be significant. At high speeds, closed loop transmit diversity does not perform well anyway and any extra degradation is likely to be small. However, at intermediate speed the degradation is likely to be more significant.

It is also worth considering that a UE will be in soft handover between a cell using timing adjustment mode J+1 and timing adjustment mode J+2. Assuming a reasonable Node B processing delay, timing adjustment mode J+2 is only required for cell sizes above 10km. Typically cell sizes will be much smaller than this and so in many cases a network will not have to resort to using timing adjustment mode J+2 on any cells. Of course, for Node Bs with poorer processing times the cell radius requiring timing adjustment mode J+2 will be smaller. Currently there are no performance requirements in rel99, rel4 or rel 5 for the Node processing time.

It should also be noted that these consequences do not apply to all mobile implementations. A mobile implementation that demodulates data using a phase reference obtained from combining CPICH phase estimates will suffer these consequences. However, a mobile implementation that obtains the phase reference solely from the dedicated pilot symbols would not suffer any impact. So this will place additional functionality to a UE, which can already meet the requirements in terms of performance

Given that the degradations are only in unusual timing conditions, in soft handover, likely speed dependent, for particular mobile implementations and possibly poor Node B processing time, we do not consider that the overall system impact is sufficient to justify an essential correction to release 99 or release 4.

Previous issues with transmit diversity in SHO

Previous issues with the behaviour of transmit diversity in soft handover have arisen in RAN1. It was proposed to specify how the UE should behave in the case that the network applied transmit diversity only to a subset of the radio links in the active set. This could happen in the case that the UE is soft handover between a cell that has diversity transmit antennas and one that supports only a single transmit antenna. This is a likely scenario in a typical deployment.

At the time RAN1 considered that it was a new functional requirement that could impact UE implementations and so it could not be added for release 99 or release 4. The correct handling is mandated in the release 5 specification but in release 99 and release 4 it is permitted for the UE to process all radio links as if transmit diversity is applied. The consequence of this is that the UE might apply transmit diversity processing to a radio link which is not transmitted with transmit diversity. The performance degradation associated with this was never fully quantified.

Recalling this earlier issue shows that the release 99 and release 4 specifications already have a problem related to the behaviour of transmit diversity in soft handover. Given this, the present issue regarding the behaviour transmit diversity in soft handover should be handled in a consistent manner.

Discussion of UE capabilities and RRC

It was raised during discussion in RAN1 that the RRC signalling has the ability signal the closed loop timing mode on a per radio link basis and this therefore implies it must be supported by layer 1. However, it should be noted, that just because the signalling has a certain ability does not imply that L1 must support it. The RRC signalling has the ability to signal many things which we do not require the UE layer to support - a few examples are:

1. Dedicated pilots;
2. Transmit diversity applied to a subset of the radio links in the active set and not applied to the other radio links, a case where we allow the UE to process as if transmit diversity is applied to all radio links (as described in the previous section);
3. Different SF on different radio links;

This is simply to demonstrate that UE manufacturers cannot rely on RRC signalling possibilities to determine the UE layer 1 requirements - the layer 1 requirement must be captured in the RAN1 specifications.

Conclusion

From the above discussion, we make the following conclusions:

1. The CR proposes to add a new functional require on the UE which are implementation specific.
2. The CR does not indicate the system impacts (which was agreed at the last RAN)
3. Given that the degradations are only in unusual timing conditions, in soft handover, likely speed dependent, and for particular mobile implementations, we do not consider that the overall system impact is sufficient to justify an essential correction.
4. The existing specifications already contain some issues with the behaviour of transmit diversity in soft handover that are not resolved until release 5. The present problem relating to transmit diversity in soft handover should be handled in a consistent manner.
5. If new functional requirements need to be specified than these new functional requirements should be specified in the next open release of the specification, which is release 6. However, as indicated at the RAN1 meeting, Motorola is prepared to accept the CR in release 5.