TSG-RAN Working Group 1 meeting#12 **TSGR1(00)0492**

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**Agenda Item:**
**Source:** CWTS
**To:** TSG RAN WG1
**Title:** Smart Antenna technolgy for low chip rate TDD option
**Document for:** Approval

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## introduction:

this paper described the smart antenna and beamforming processing. It should be noted that this paper only describes a preferred approach to beamforming, other high performance techniques may also be applicable

## Conclusion:

It is proposed to discuss and to include the following text proposal in TR25.928.

---------- changes to 25.928 begin ----------

## 7.2.2.4 beamforming and Tx diversity

## 7.2.2.4.1 beamforming by Smart Antenna

## [Description:]

A smart antenna system is composed of an array of multiple antenna elements and coherent transceivers with advanced digital signal processing algorithms. Instead of a single fixed beam pattern from a traditional antenna, the smart antenna can dynamically generate multiple beam patterns, each of them is pointed to a particular UE, and such beam patterns can adapt to follow any UE intelligently. On the Rx side of Node B, such a feature, i.e., spatial selective reception at the Node B can greatly minimize co-channel interference from the co-channel UEs at different locations, thus increase the Rx sensitivity and lead to higher capacity. It can also effectively incorporate multipath components to combat multipath fading. On the Tx side of Node B, intelligent spatially selective Tx (downlink) beamforming can also greatly reduce the interference to other co-channel UEs, then dramatically save the output power requirement and lead to higher capacity.

The low chip rate option is mainly based on the smart antenna technology. Some main technical features of the low chip rate TDD option such as 5 ms sub-frame structure are based on the smart antenna request. These technical relationships will be explained in details in other TRs which mention these features.

When DL beamforming or TX Diversity is used, at least for the resource units beamforming/Tx Diversity is applied to and which are allocated to dedicated channels, the resource units shall get one individual midamble per user or per resource unit according to midamble generation, even in DL.

## [Rationale:]

The smart antenna array is composed of $N$ antenna elements, $N$ related feed cables and $N$ coherent RF transceivers in RF part. By use of the A/D converters or D/A converters in analog baseband (ABB), the Rx and Tx analog signals are interfaced to the digital baseband (DBB) part over the high-speed data bus. In this model, all antenna elements related feed cables and coherent RF transceivers will be calibrated before operating.

## Beamforming

For the Node B is equipped with smart antenna array and DBB DSP, when a signal comes from one UE within the coverage of the Node B, each antenna element and coherent RF receiver will get it. Because of the different location of the different antenna element, the phase of the Rx signal will be different. In case of multipath propagation, each path will come from different directions with different amplitude and delay. Then the Rx signal at each antenna element will show different phase and amplitude. After the front-end processing in RF part and A/D converters processing in ABB, digitized Rx signal with the phase and amplitude information will be sent to DSP in DBB part. After despreading in the DBB processor, the Rx data of each code channel may be obtained. The purpose of smart antenna in uplink is to find the best $E_b/I_0$ after the combination. Theoretically, spatial reception at Node B can add up all useful signals while canceling all multipath interference. The next step is to realize downlink beamforming. The Tx signal of the each code channel is got by some algorithms that enable the UE to obtain the best $E_b/I_0$ .In TDD system, because of the symmetrical performance in wave propagation, it is possible to directly use the spatial reception at Node B results to downlink beamforming.

## Fast beamforming

It is always very important to reach fast beamforming to catch the time variation in mobile network. The Node B should have a in-time reaction to the fast changing beam patterns. And this is the reason that the TDD interval in low chip rate option is 5ms while 10ms in high chip rate option. This value is a compromise in considering both the number of time slots and the switching speed of RF components.

In smart antenna system, the BTS need receive the UpLink data first, then decide the UE's position, and then beamform to UE in Downlink, but the UE does not need to transmit regularly for the Node B to determine the antenna weights when it is in idle mode.

## [Explanation difference:]

For high chip rate option, the chapter about beamforming is already existed.

The difference to high chip rate option is that not only each user can get one midamble but also each resource allocated to that user can (but need not to) get an individual midamble. The benefit of this is that the Joint Detection in the UE and the signaling is eased.

---------- changes to 25.928 end ----------