UPLINK ARRAY PROCESSING EVALUATION FOR THE FDD MODE OF UTRA

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1. INTRODUCTION

In this paper, results of link level simulations for the W-CDMA Alpha concept group proposal within SMG are presented. The evaluation work was carried out following FRAMES recommendations described in [1]. Hence, the “Actual Value Interface” (AVI) was envisaged as the most suitable connection between link-level and system-level simulations. Results show improvements of 5-10dB in the Eb/Io required for the typical raw bit error rates of interest with respect to the single-sensor case, and even higher when null steering towards the directions of arrival of the interferents is performed.

2. CHANNEL AND SCENARIO CHARACTERISATION

All simulations were carried out using a channel model based on the Gaussian wide-sense stationary uncorrelated scattering (GWSSUS) hypothesis, which assumes independence between the mechanisms leading to azimuth and delay dispersion; thus, wide band channels were simulated by means of time-variant tapped delay lines. In particular, the models regarded as “Outdoor to Indoor and Pedestrian” and “Vehicular” in [2] were considered for the generation of the channel frequency selectivity, whereas the angular approach presented in [3] was assumed for the narrow band channels assigned to each tap. Each individual flat-fading channel was in turn generated with a ray deployment, where the number of impinging wavefronts was set equal to a Poisson random variable with mean E[L]=25 rays. In addition, a Laplacian Power Angular Spectrum was considered, along with a gaussian distribution of the different directions of arrival for each user [3]. The Power Angular Spread was fixed to 8 degrees for all taps and scenarios. The mobile speed was set to 3km/h and 120km/h for the Pedestrian and Vehicular models respectively. According to the Actual Value Interface, the simulation duration was set equal to the minimum power control actualization period, namely 0.625ms.

The simulation scenario was based on a linear equally spaced array of 8 antennas, in which the interelement separation was half wavelength at the center frequency. A uniform pdf within [-60,60] degrees was adopted for the mean DOA of the different users, who were supposed to generate a single PDCCH together with its associated PDCCH. Both channels were transmitted using a dual-channel QPSK modulation after being spread to the chip rate (4.096 Mcps) with two different channelization codes and subsequently complex scrambled by a mobile-station specific scrambling code. OVSF codes and complex sequences composed of two different codes from the Very Large Kasami set of length 256 were utilized to perform the channelization and scrambling operation respectively.

The main difficulty that arose when simulating a W-CDMA environment resided in taking into account all possible bit rates and consequently spread factors that might be involved in a real scenario. In order to overcome this problem, two different kinds of users were defined with regard to the type of service that they would require, i.e., low bit rate (LBR) and high bit rate (HBR) users. The latter will clearly have a higher bandwidth demand and, consequently, an actual mobile network will be capable of handling a high number of LBR users whereas the number of mobiles requiring a HBR service will be limited. Furthermore, the higher the bit rate, the more transmitted power will be needed in order to preserve a given quality. Bearing that in mind, we can conclude that LBR users can be properly modeled as omnidirectional gaussian white noise. In our case, a constant spread factor equal to 8 was considered for both desired user and interferents (supposed to come from HBR users only). Nonetheless, we stress that results can be extrapolated to any other spreading factor, since BER is always expressed in terms of bit energy instead of signal power.

3. ALGORITHMS UNDER TEST

Two uplink array-processing algorithms were considered in the performed simulations: the Vectorial Rake Receiver (V-Rake) and the Filtered Training Sequence Multisensor Receiver (FTS-MR) [4] [5]. The first one is a generalization of the Rake Receiver for an array observation and is based on a two-dimensional estimation of the propagation channel. This estimation is derived from the Pilot bits of the PDCCH and is computed every 256 chips. The second one is a good representative of the narrowband time reference beamformers, as it spatially filters the received snapshot to further perform a detection of the resulting signal. The weights are designed to minimize the squared error between the received signal and a

![Figure 1. Algorithms under consideration.](image-url)
The proposed frameworks for both approaches are depicted in Figure 1. Two interfering scenarios were simulated for each delay power profile model (“Vehicular” and “Pedestrian”), one with a single dominating HBR interferent and another with five. Apart from the array beamforming algorithms presented in Section 3, a single-sensor Rake receiver was considered for comparison purposes. Results are depicted in terms of raw (uncoded) BER in Figure 2. Although simulations took into account a high range of LBR power (reflected in the Eb/No ratio), only results with Eb/No=10dB are presented herein. Note that the BER is always expressed as a function of the instantaneous Eb/Io per sensor (i.e., received by a single antenna and measured within an actualization period of the fast power control). Thanks to that, a conventional planning tool can directly use these results and therefore disregard the existence of adaptive antennas.

Comparing the performance of the V-Rake and the single sensor Rake receiver, it can be observed that a gain of 5-10 dB in the Eb/Io required for the typical raw BER values \((10^{-1}-10^{-2})\) is attained by the former. This gain turns to be higher than 15 dB when a classical beamformer with null steering towards the directions of the interfering users is used.

5. CONCLUSIONS

Preliminary results show that current Alpha concept group proposal for UTRA can benefit from adaptive antenna implementation at base stations. Uplink link level simulation results using AVI illustrate an Eb/Io improvement of 5-15dB depending on the reference raw BER and the receiver architecture. These results have been obtained assuming that the desired user is characterized by a HRB, but can be easily extrapolated to an arbitrary case. Performance vs. complexity trade-off of the different schemes will be studied and reported in the ACTS project SUNBEAM.

6. REFERENCES


