Agenda item:	AH24 : High Speed Downlink Packet Data Access
Source:	Lucent Technologies
Title:	Text contribution on MIMO UE complexity
Document for:	Text contribution for TR

1. INTRODUCTION

We propose the following text for the HSDPA TR for Section 7.4.2 regarding UE MIMO complexity. The new proposed text is highlighted below.

2. PROPOSED TEXT

The MIMO UE will require multiple uncorrelated antennas and additional baseband processing to perform space-time combining and spatial processing on substreams which share the same code.

High spectral efficiencies of the MIMO system are achieved when there is uncorrelated fading among pairs of transmitter and receiver antennas. With 2GHz carrier frequency, an array of 4 antennas with dual-polarization requires only 7.5cm of linear space. Because the terminal receiver is at the same level as local scatterers, ½ wavelength antenna spacing can generally achieve a fair amount of decorrelation of multipath signals, particularly in cases in which there is no direct path between receiver and transmitter (Rayleigh fading) [1] . However, the final correlation could be increased by factors such as the proximity to the human body and other objects

A complexity estimate for MIMO receivers is proposed in [1], and includes an outline complexity breakdown for specific UE components including antenna components, RF signal processing, baseband signal processing, fixed costs, and processing for layers 2 and above. Reference [1] indicates that – compared to a single antenna receiver operating at 10.8Mbps – the complexity of a 4 antenna MIMO receiver operating at 21.6 Mbps would be up to 2 times greater.

However, performance data for the receiver that formed the basis for this complexity analysis has only been offered for time non-dispersive channels, and additional baseband signal processing (including chip-level processing such as equalization or interference cancellation) may be required to deal with delay-spread conditions. Further, a common model for UE complexity evaluation has not yet been established in TSG-RAN WG1 and the UE complexity estimate of [1] has not been verified by other manufacturers. Accordingly, while the complexity estimates of [1] are useful, they should be regarded as very preliminary.

~~A high-level investigation on the feasibility of a MIMO baseband processor was summarized in [4]. The main baseband components are a despreader, a space-time combiner, a detector for eliminating spatial interference, and a turbo decoder. It was shown that the turbo decoder requires the majority of the processing power. For a 2 transmit antenna, 2 receive antenna system, the detector portion accounts for about 5% of the total processing and the turbo decoder accounts for about 85% of the processing. For a 4 transmitter, 4 receiver system, the detector and turbo decoder account for about 20% and 70% respectively of the total processing. Compared to a conventional single antenna receiver for HSDPA which requires~~

~~about $1.6x10^9$ operations per second, the 2 antenna receiver requires $3.3x10^9$ operations per second and the 4 antenna receiver requires $7.9x10^9$ operations per second. These computational requirements were estimated assuming brute force processing techniques but are already within the range of existing hardware technologies. More detailed studies will mostly likely reduce the processing requirements significantly.~~

~~With regard to RF complexity, for a terminal with M antennas, where M in this case is assumed to be 2 or 4, one could simply replicate the conventional RF/IF chain M times and perform baseband combining. [However, one may potentially lower the complexity by performing combining in RF or using a homodyne chip solution. In performing combining in RF, the UE cost can be reduced by using a single IF chain and by omitting baseband combiners. Using homodyne chip technology, the entire RF/IF chain is implemented in silicon, resulting in significantly reduced cost. The practicality w.r.t cost and complexity of the above mentioned technologies needs to be investigated.]??~~

3. REFERENCES

[1] Lucent. Further Discussion on UE Complexity for MIMO architectures. TSG_R WG1 document TSGR1#19(01)0303, Feb. 27 – Mar. 2, Las Vegas, USA