3GPP TSG RAN WG1 **TSGR1#19(01)0306**

Agenda item:	AH24 : High Speed Downlink Packet Data Access
Source:	Lucent Technologies
Title:	MIMO physical layer description
Document for:	Proposed text contribution for TR

1. INTRODUCTION

We propose text for the section 6.5 in the TR [1] on the physical layer structure of mulitple-input/ multiple output (MIMO) systems.

2. PROPOSED TEXT

In a conventional single antenna HSDPA transmission, a set of N downlink physical channels (codes) is shared among many users. Using a MIMO architecture with M transmit antennas, the same set of codes is used; however each code is re-used M times and each modulates distinct data substreams. More specifically, a high rate data source is coded, rate-matched and interleaved. As seen in the figure below, this coded data stream is then demultiplexed into MN substreams, and the nth group (n = 1 … N) of M substreams is spread by the nth spreading code. The mth substream (m = 1 … M) of each group is summed and transmitted over the mth antenna so that the substreams sharing the same code are transmitted over different antennas. Mutually orthogonal dedicated pilot symbols are also added to each antenna's common pilot channel (CPICH) to allow for coherent detection. For M = 2 or 4 antennas, the pilot symbol sequences for, respectively, 2 antenna STTD or 4 antenna close-loop transmit diversity can be used.

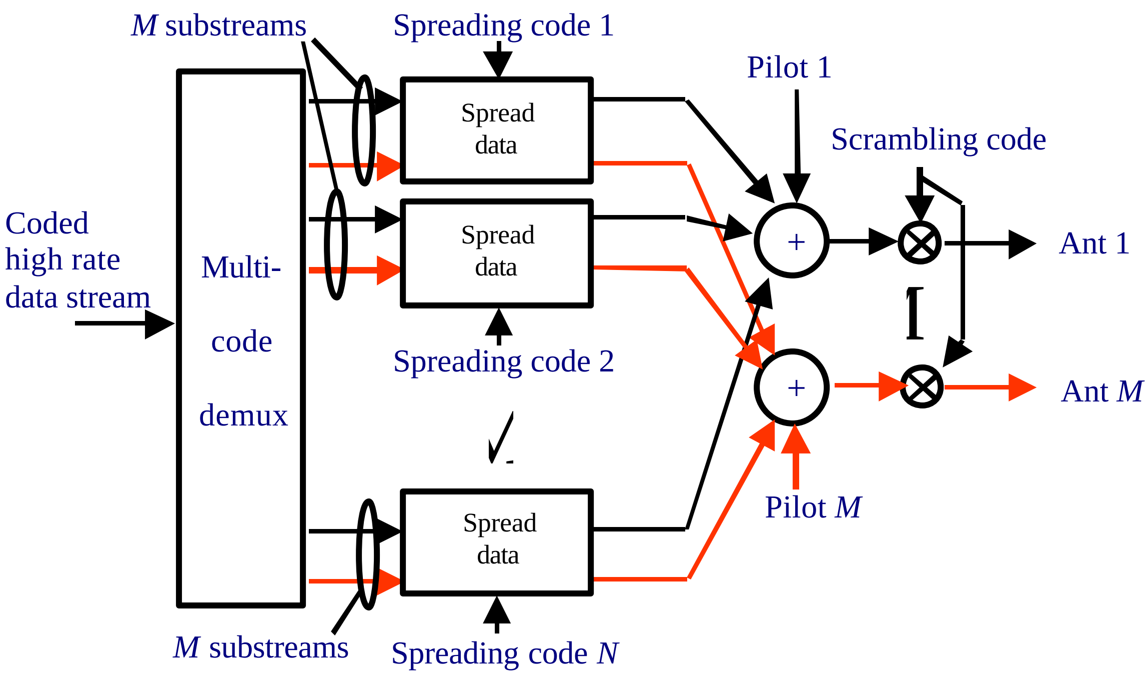

Figure X. Block diagram of MIMO transmitter

To distinguish the *M* substreams sharing the same code, the UE uses multiple antennas and spatial signal processing. A representative MIMO receiver with *P* antennas is shown in the figure below. For coherent detection at the UE, complex amplitude channel estimates are required for each transmit/receive antenna pair. In a flat fading channel, the channel is characterized by *MP* complex channel coefficients. In frequency selective channels, the channel is characterized by *LMP* coefficients where *L* is the number of rake receiver fingers. Channel estimates can be obtained by correlating the received signals with the *M* orthogonal pilot sequences. Compared to a conventional single antenna receiver, the channel estimation complexity is higher by a factor of *M*. For data detection, each antenna is followed by a bank of filters matched to the *N* spreading codes. In general, there would be *LN* despreaders per antenna. For each of the *MN* distinct data substreams, the *LP* corresponding despreader outputs are each weighted by the complex conjugate of its corresponding channel estimate and summed together to form a sufficient statistic. This procedure is known as a space-time rake operation and is simply the multiple antenna generalization of the conventional rake combiner.

The sufficient statistics of *M* substreams sharing the same code would each be contaminated by spatial multiaccess interference (MAI). However in flat fading channels, as a group, these substreams are not affected by the substreams transmitted on the other codes because the code orthogonality is maintained by the channel. For each group of *M* co-code substreams, a multiuser detector is used to remove the effects of the MAI. Examples include the maximum likelihood (ML) detector and the Vertical BLAST (V-BLAST) detector. The ML detector can be derived in a straightforward manner from the noise covariance of the sufficient statistic vector. Because the ML complexity is exponential with respect to *M*, the sub-optimal but less complex V-BLAST detector is a viable alternative. This well-known MIMO detector consists of two components: a linear transformation and an ordered successive interference canceller. The linear transformation eliminates MAI and can be based on a zero-forcing or minimum mean squared error (MMSE) criterion. Following the transformation, the coded symbols of the substream with the highest signal to noise ratio (SINR) are detected, and its signal is subtracted from the sufficient statistics. Using this revised sufficient statistic vector, the linear transformation and ordered successive interference cancellation are repeated until all substreams have been detected. Following the MIMO detector, the *MN* substreams are multiplexed into a single high data rate stream, demapped to bits, deinterleaved, and decoded.

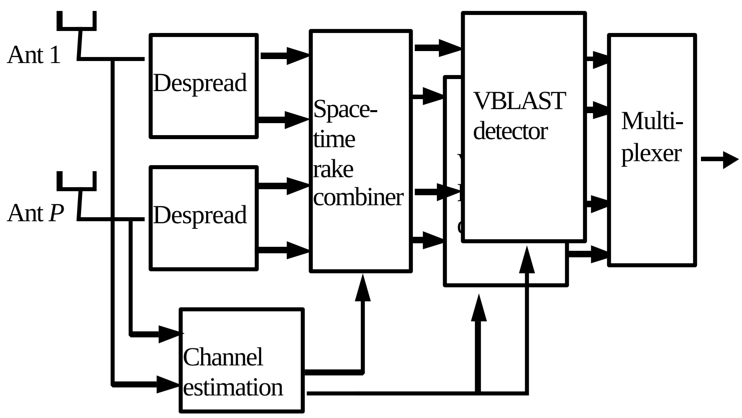

Figure Y. Block diagram of a MIMO receiver

3. REFERENCES

[1] 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Physical Layer Aspects of UTRA High Speed Downlink Packet Access; (Release 2000), (3G Technical Report (TR) 25.848, version 0.2.1), Tdoc R1-01-0117, TSG-RAN WG1; January 15th-18th, 2001, Boston, USA.