Agenda item:	AH24 : High Speed Downlink Packet Data Access
Source:	Lucent Technologies
Title:	Complexity of Node B for MIMO architectures
Document for:	Proposed text contribution for TR

1. PROPOSED CHANGES

We propose the following changes for Section 7.4.1 of the Technical Report [1]:

1. Replace "Eb/N0" with "Ior/Ioc".
2. Replace "A serially concatenated convolutional coding" with "Parallel concatenated convolutional coding". Also remove the editor's note that follows this sentence because it is no longer applicable.
3. Replace the two performance figures showing FER versus Eb/N0 with corresponding figures showing FER versus Ior/Ioc.

The modified text follows.

2. PROPOSED TEXT

7.4.1 MIMO Performance Evaluation

Link level simulations were performed and the frame error rate (FER) versus Ior/Ioc were measured for a variety of system architectures. We first compare the systems for a fixed data rate and show that, compared to the conventional transmitter, MIMO architectures can achieve the same frame error rate at much lower Ior/Ioc. Next, we show how for a similar Ior/Ioc, the MIMO architectures can achieve higher data rates.

The data rate was fixed at 10.8 Mbps, achieved assuming a chipping rate of 3.84 Mchips/sec, a spreading factor of 32 chips per coded symbol, N = 20 spreading codes, and appropriate coding rates and data constellation sizes. A parallel concatenated turbo decoding with 8 decoding iterations was used**.** The system architectures for M transmit antennas and P receive antennas are given in Table 1.

Puncturing for the (4,4) system is used to achieve 10.8 Mbps. A flat fading channel with 3km/hr fading, perfect channel estimation, and uncorrelated fading between antenna pairs for the MIMO systems is assumed. Figure 1 below shows the FER versus Ior/Ioc. Compared to the conventional transmitter, there are gains of about 9dB and 16dB for the (2,2) and (4,4) systems, respectively, at 10% FER. The enormous performance gains are due to a combination of diversity, receiver combining gain, and increased spectral efficiency due to MIMO processing. We emphasize that these gains are achieved using the same code resources (20 codes) as the conventional transmitter.

Table 1. System Architecture for achieving 10.8 Mbps

(*M*, *P*)	Tx technique	Code rate	Modu-lation	Rate per substream	Number of substreams	Total data rate
(1,1)	Conven-tional	¾	64QAM	540 Kbps	20	10.8Mbps
(2,2)	MIMO	¾	8PSK	270 Kbps	40	10.8Mbps
(4,4)	MIMO	~½	QPSK	135 Kbps	80	10.8Mbps

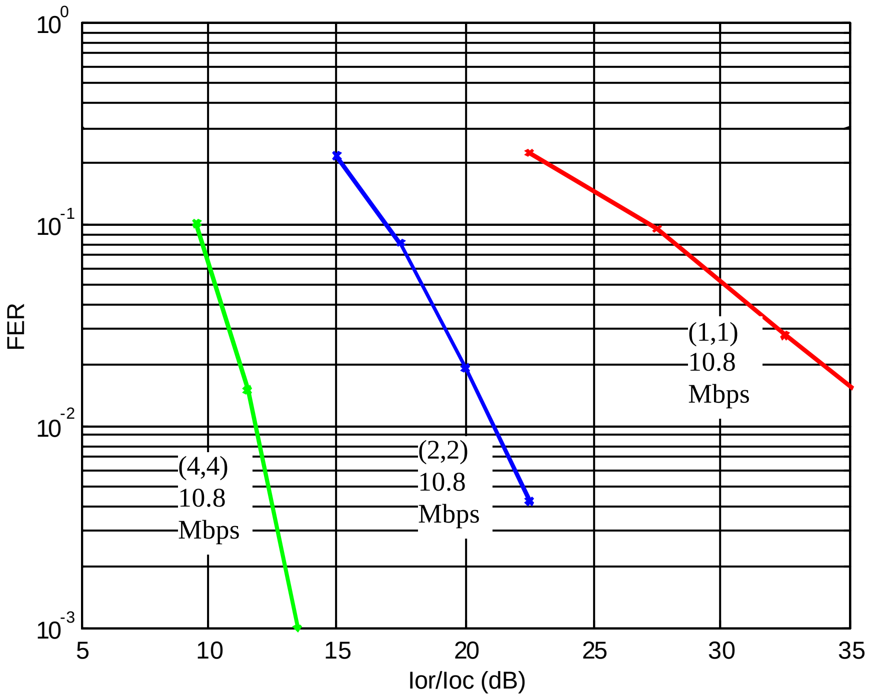

Figure 1. Flat fading channel performance for 10.8 Mbps

Using MIMO techniques, the maximum data rate can increase to 14.4 for the (2,2) system and up to 21.6 Mbps for the (4,4) system. As shown in the Table 2, the constellation sizes are still smaller than those of the conventional transmitter. As seen in Figure 2, the required Ior/Ioc's for these rates are less than that for the conventional system operating at 10.8Mbps.

Table 2. System Architecture for achieving 21.8 Mbps

(*M*, *P*)	Tx technique	Code rate	Modu-lation	Rate per substream	Number of substreams	Total data rate
(1,1)	Conven-tional	¾	64QAM	540 Kbps	20	10.8Mbps
(2,2)	MIMO	¾	16QAM	360 Kbps	40	14.4Mbps

(4,4)	MIMO	¾	QPSK	180 Kbps	80	14.4Mbps
(4,4)	MIMO	¾	8PSK	540 Kbps	80	21.6Mbps

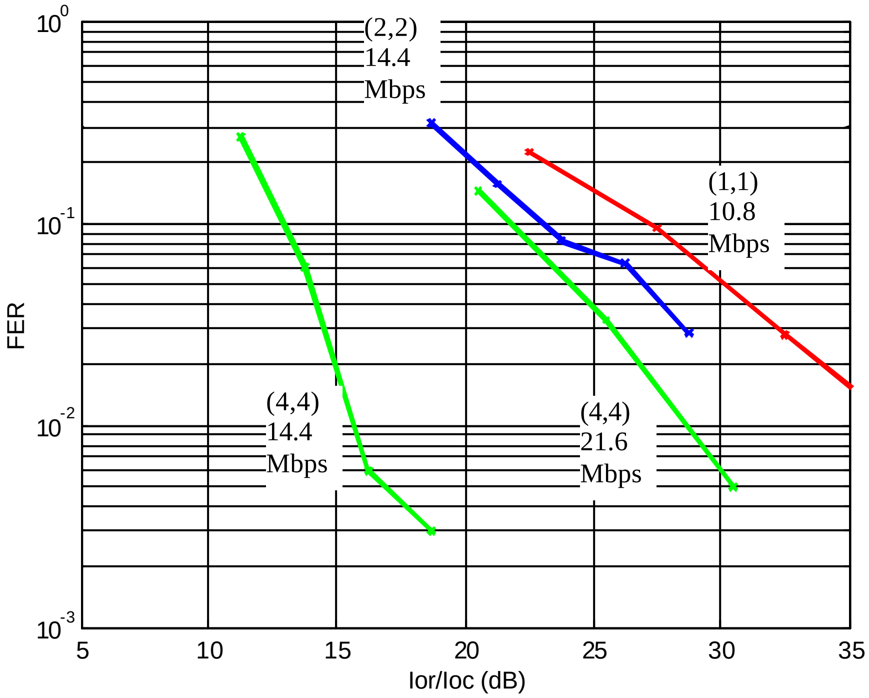

Figure 2. Flat fading channel performance for higher data rates

One way to interpret the Ior/Ioc gains for MIMO is that the high data rates can be achieved with less transmit power. Alternatively, if the DSCH is transmitted at a fixed power, then the MIMO gains translate into the higher data rates being used over a larger fraction of the cell area. Under this assumption of a rate-controlled DSCH, a system level study employing a base station scheduler showed that the average sector throughput using a (4,4) MIMO system increases by a factor of 1.8 and 2.8 for proportional fair and maximum C/I scheduling, respectively, compared to a conventional (1,1) system [1]. (As an aside, a surprising result in [1] is that under a proportional fair scheduler, the conventional (1,1) system actually outperforms both the (2,1) and (4,1) diversity systems when there are multiple users vying for the DSCH.) It may be noted that the system level simulation did not use all the assumption as outlined in Annex A.

Additional link level studies investigated the effect of higher doppler frequencies, channel estimation, and correlated channels on the MIMO performance [2]. At 10% FER, compared to a baseline with low doppler, perfect channel estimation, and uncorrelated channels, the worst case loss in required Ior/Ioc is about 2dB, occurring in an indoor correlated channel with channel estimation. Hence with regard to these impairments, the MIMO architecture is a robust technique for providing high speed downlink packet service in excess of 10.8 Mbps.

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 R1-00-1480, TSG-RAN WG1; January 15th-18th, 2001, Boston, USA.
[2] Lucent. Complexity of Node B for MIMO architectures. TSG_R WG1 document TSGR1#18(01)0130, , 15-18th, January 2001, Boston, USA.
[3] D. Chizhik, F. Rashid-Farrokhi, J. Ling, A. Lozano, "Effect of antenna separation on the capacity of BLAST in correlated channels," to appear in *IEEE Communications Letters*.