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Further link level results for HSDPA using multiple antennas

RAN WG1 #17
Stockholm, Sweden
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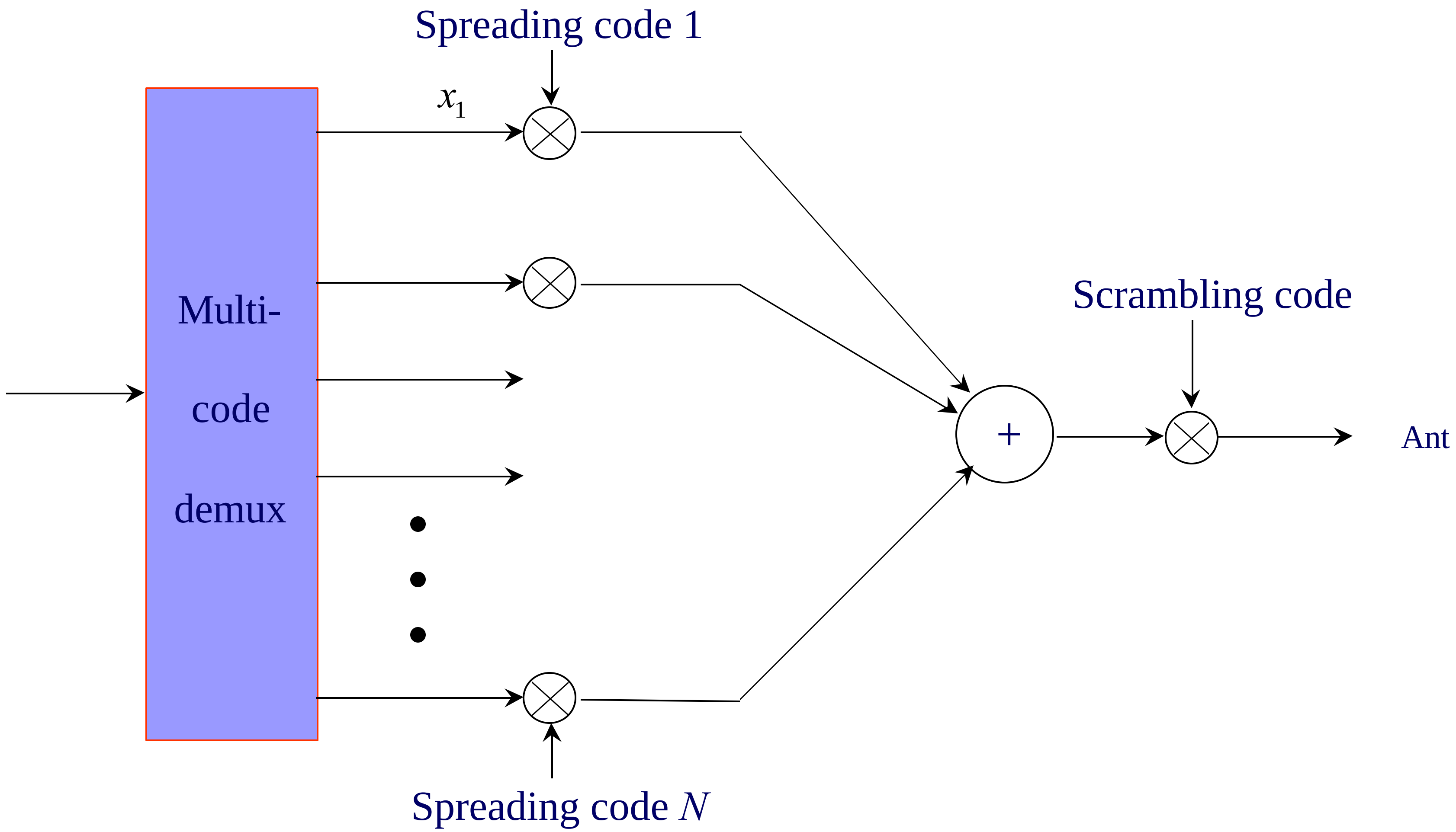
Background

- Using multiple-input multiple-output (MIMO) transmission and detection techniques, one can provide high data rate transmissions at lower Eb/N0 compared to conventional single antenna techniques.
- Alternatively, higher peak data rates can be achieved using MIMO.
- Previous link level results assumed
  - flat fading channels
  - uncorrelated fading between antenna pairs
  - 3km/hr terminal speed
  - known channel at the terminal

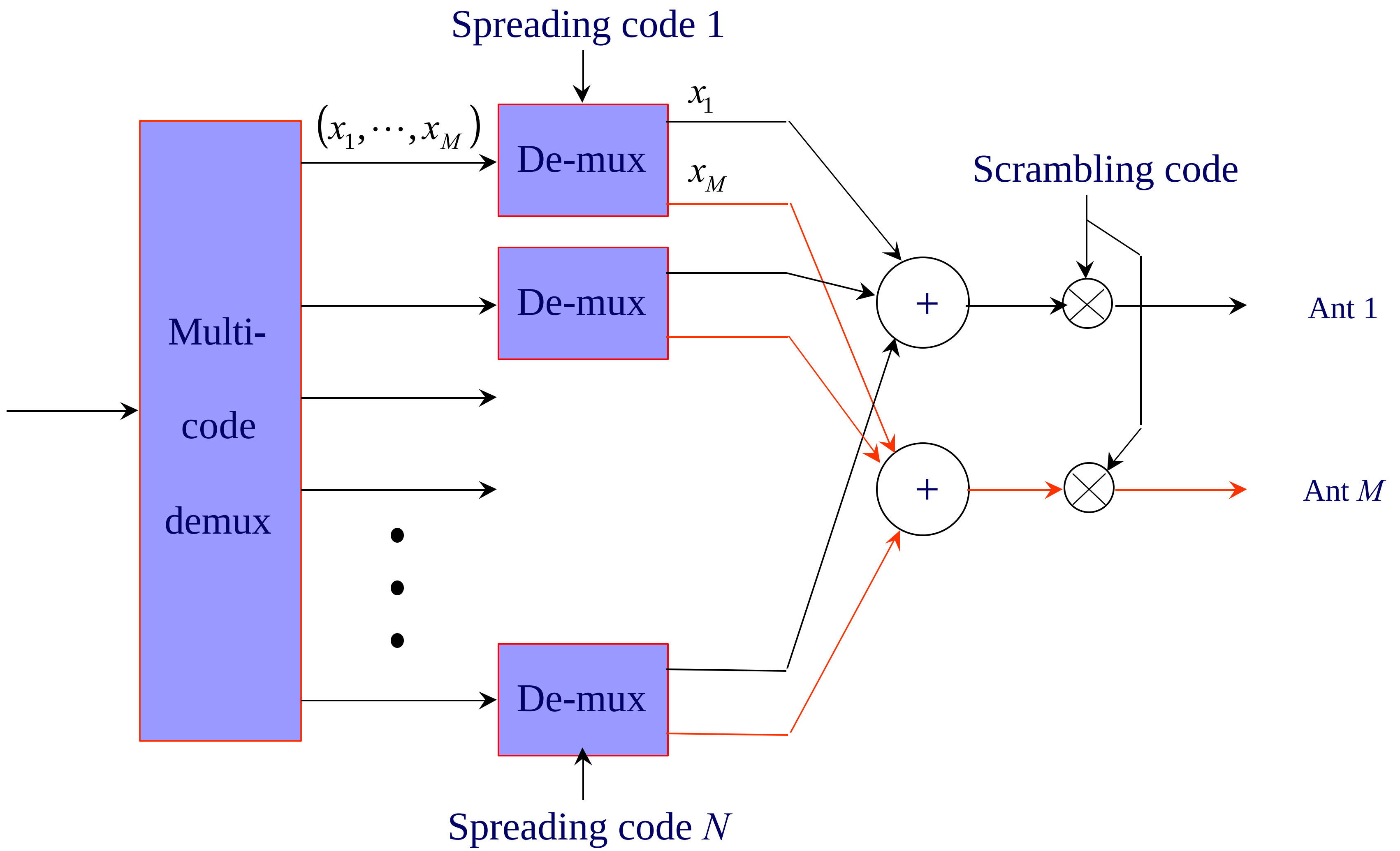
Overview

- New results consider
  - correlated fading (urban and indoor channels)
  - 30Km/hr terminal speed
  - channel estimation

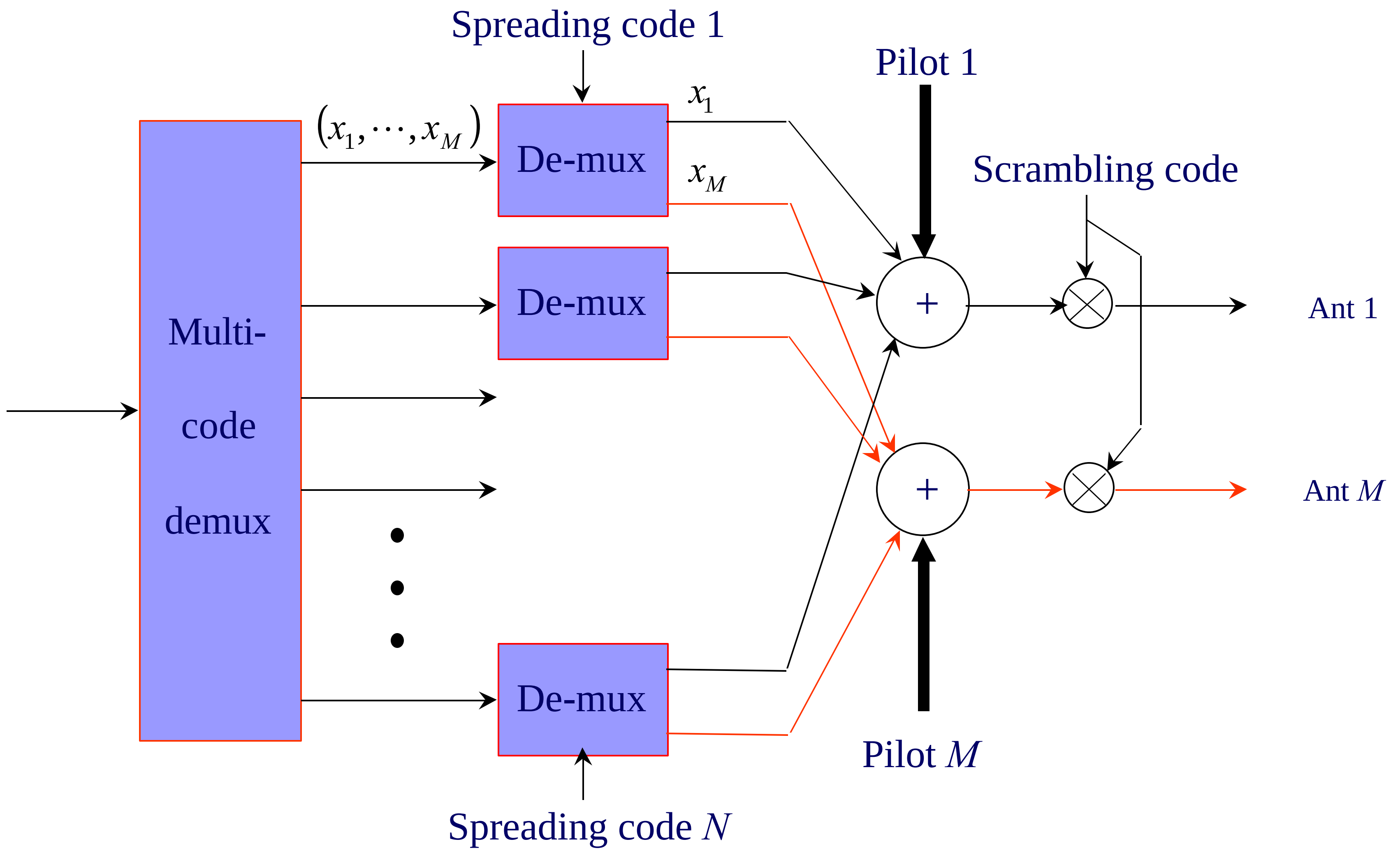
Conventional transmission



MIMO transmission with *M* Tx antennas



MIMO transmission with *M* Tx antennas



Representative transmission options

Data rate	Ant config	TX technique	code rate	modulation
10.8 Mbps	(1,1)	Conventional	3/4	64QAM
10.8 Mbps	(2,2)	MIMO	3/4	8PSK
14.4 Mbps	(2,2)	MIMO	3/4	16QAM
10.8 Mbps	(4,4)	MIMO	~1/2	QPSK
14.4 Mbps	(4,4)	MIMO	3/4	QPSK
21.6 Mbps	(4,4)	MIMO	3/4	8PSK

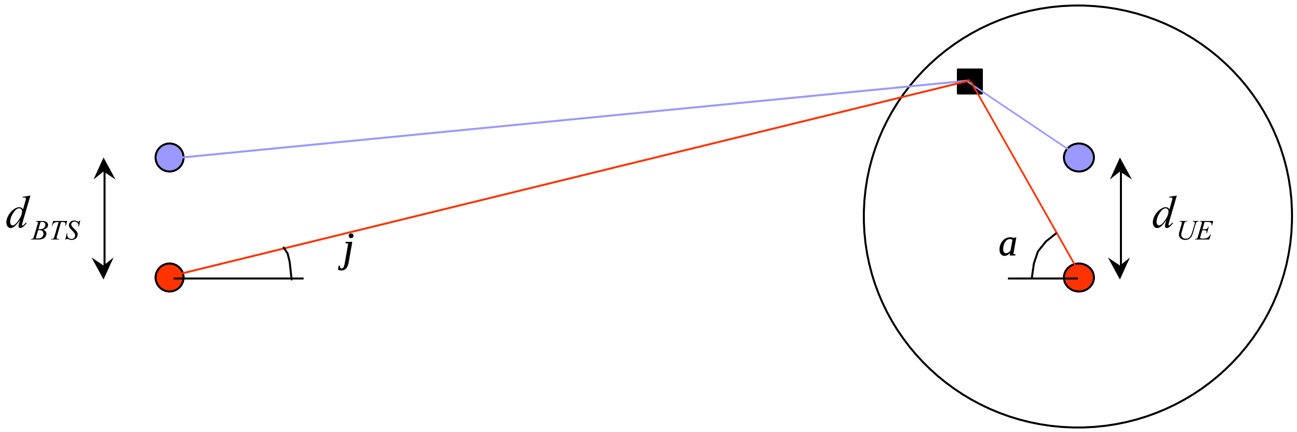
All options use $N = 20$ spreading codes.

Channel estimation

- Data sequences are length 32.
- Pilot sequences for each antenna are length 256.
  - Derived from a length 32 code which is orthogonal to the data sequences to maintain overall code orthogonality.
- Pilot power is 10% of total transmit power and power is distributed evenly among the *M* antennas.
- Channel estimation based on pilot sequence correlation.

Correlated channel model

- Derived from ring of scatterers surrounding terminal [Siemens].
  - Uniform distribution of scatterers: $\in \left[\ _{\min},\ _{\max}\right],\ \in \left[0,2\ \right]$



- Correlation among receive antennas is independent of transmitter and correlation among transmit antennas is independent of receiver.

$$E\left[h_{m_1p_1}h^*_{m_2p_2}\right] = E\left\{\exp\left(j2\ \frac{d(m_1,m_2)\sin\ }{\ }\right)\right\}E\left\{\exp\left(j2\ \frac{d(p_1,p_2)\sin\ }{\ }\right)\right\}$$

Correlated channel parameters

	Urban	Indoor
d_{BTS}	10	2
d_{UE}	0.5	0.5
$_{min}$	7.5 deg	-70 deg
$_{max}$	52.5 deg	70 deg
$_{min}$	0 deg	0 deg
$_{max}$	360 deb	360 deg

Example: (2,2) channels

$$\mathbf{h} = \begin{pmatrix} h_{11} \\ h_{21} \\ h_{12} \\ h_{22} \end{pmatrix}, \qquad h_{ij} \quad \text{channel from Tx antenna } i \text{ to Rx antenna } j$$

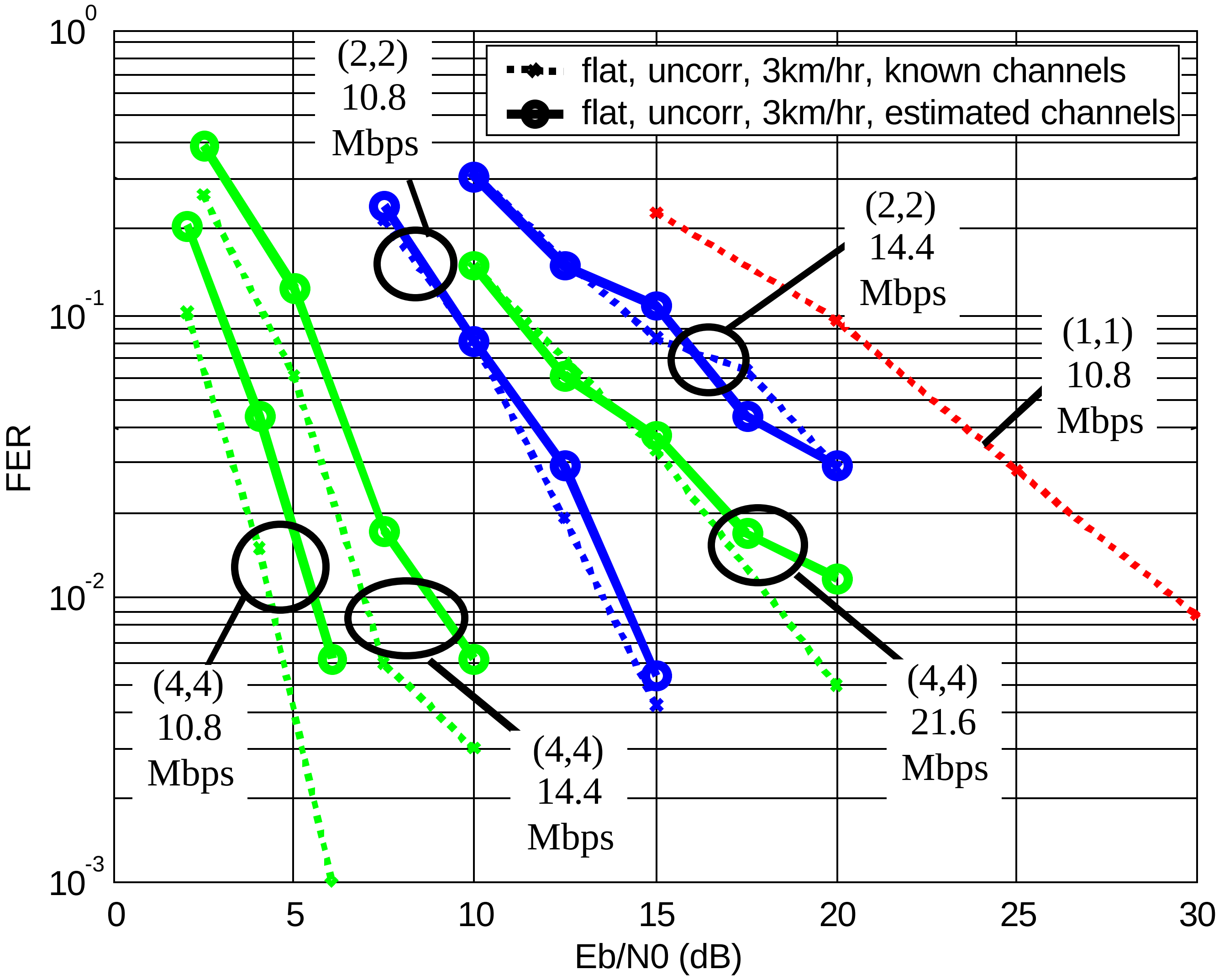
Urban channel

$$\mathbf{R} \overset{\Delta}{=} E\left[\mathbf{h}\mathbf{h}^H\right] = \begin{bmatrix} 1 & 0.05e^{-j2.3} & 0.30e^{-j3.1} & 0.01e^{j0.9} \\ 0.05e^{j2.3} & 1 & 0.01e^{-j0.9} & 0.30e^{-j3.1} \\ 0.30e^{j3.1} & 0.01e^{j0.9} & 1 & 0.05e^{-j2.3} \\ 0.01e^{-j0.9} & 0.30e^{j3.1} & 0.05e^{j2.3} & 1 \end{bmatrix}$$

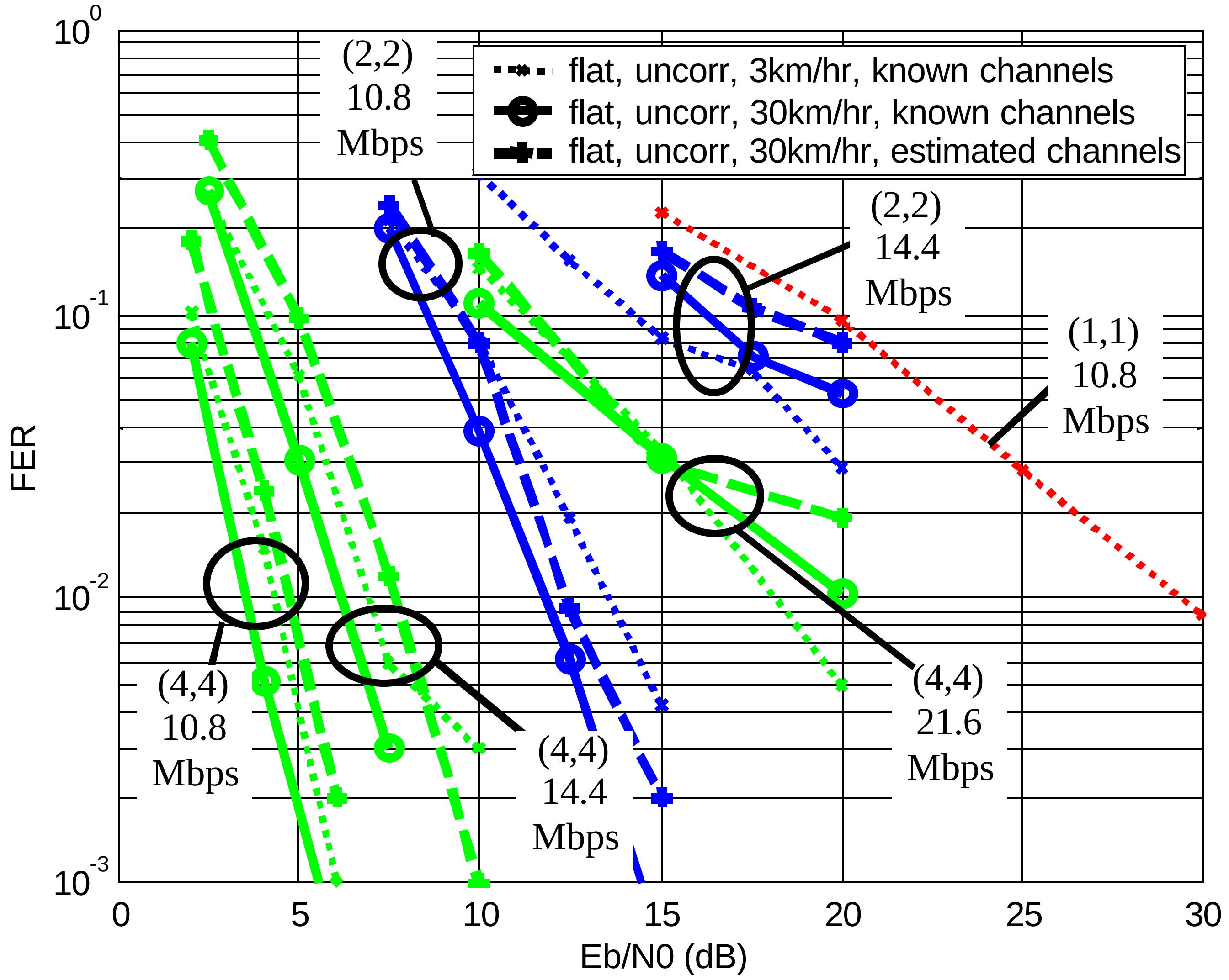
Indoor channel

$$\mathbf{R} \overset{\Delta}{=} E\left[\mathbf{h}\mathbf{h}^H\right] = \begin{bmatrix} 1 & -0.07 & -0.30 & 0.02 \\ -0.07 & 1 & 0.02 & -0.30 \\ -0.30 & 0.02 & 1 & -0.07 \\ 0.02 & -0.30 & -0.07 & 1 \end{bmatrix}$$

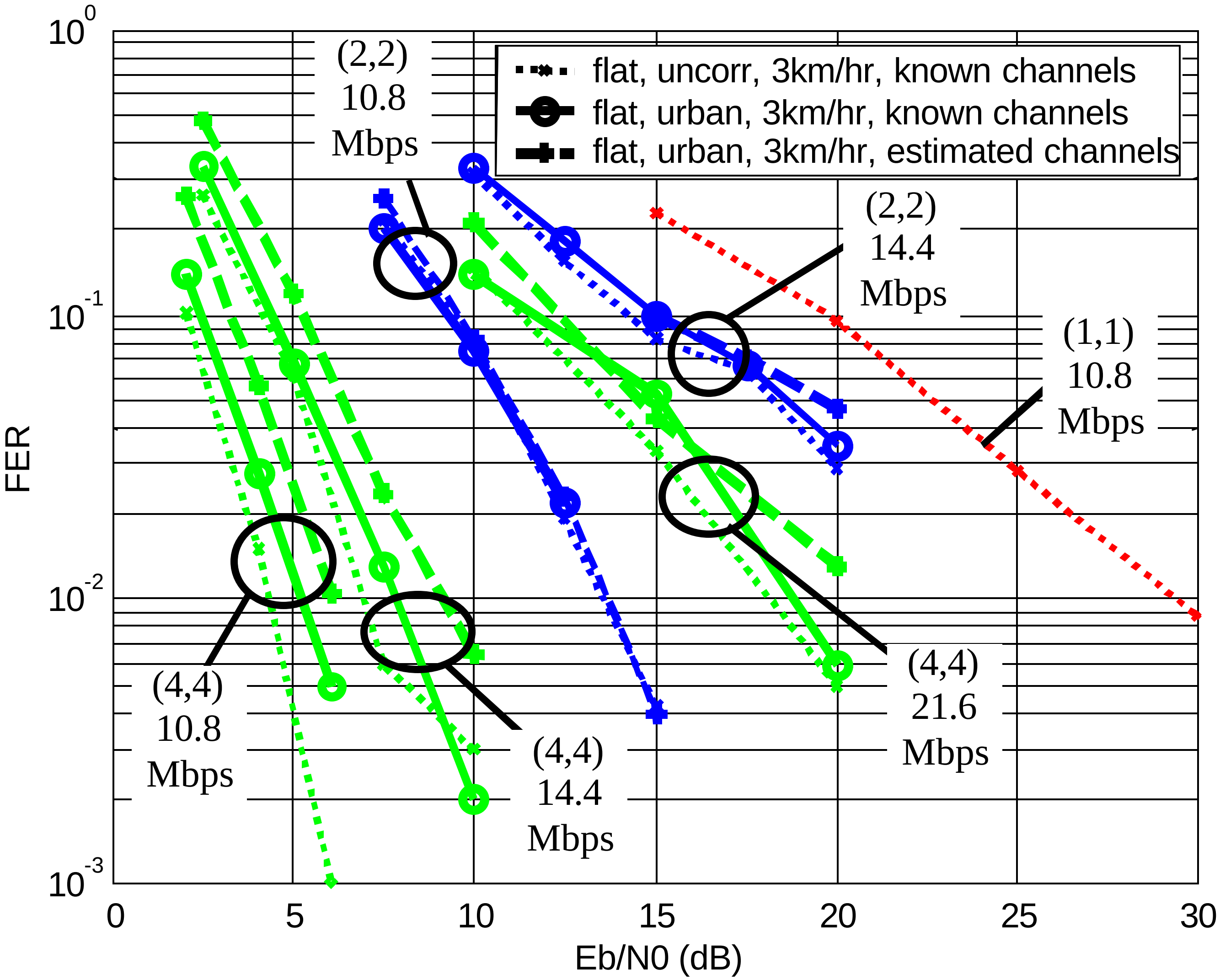
Uncorrelated channels, 3km/hr



Uncorrelated channels, 30km/hr



Urban channel, 3km/hr



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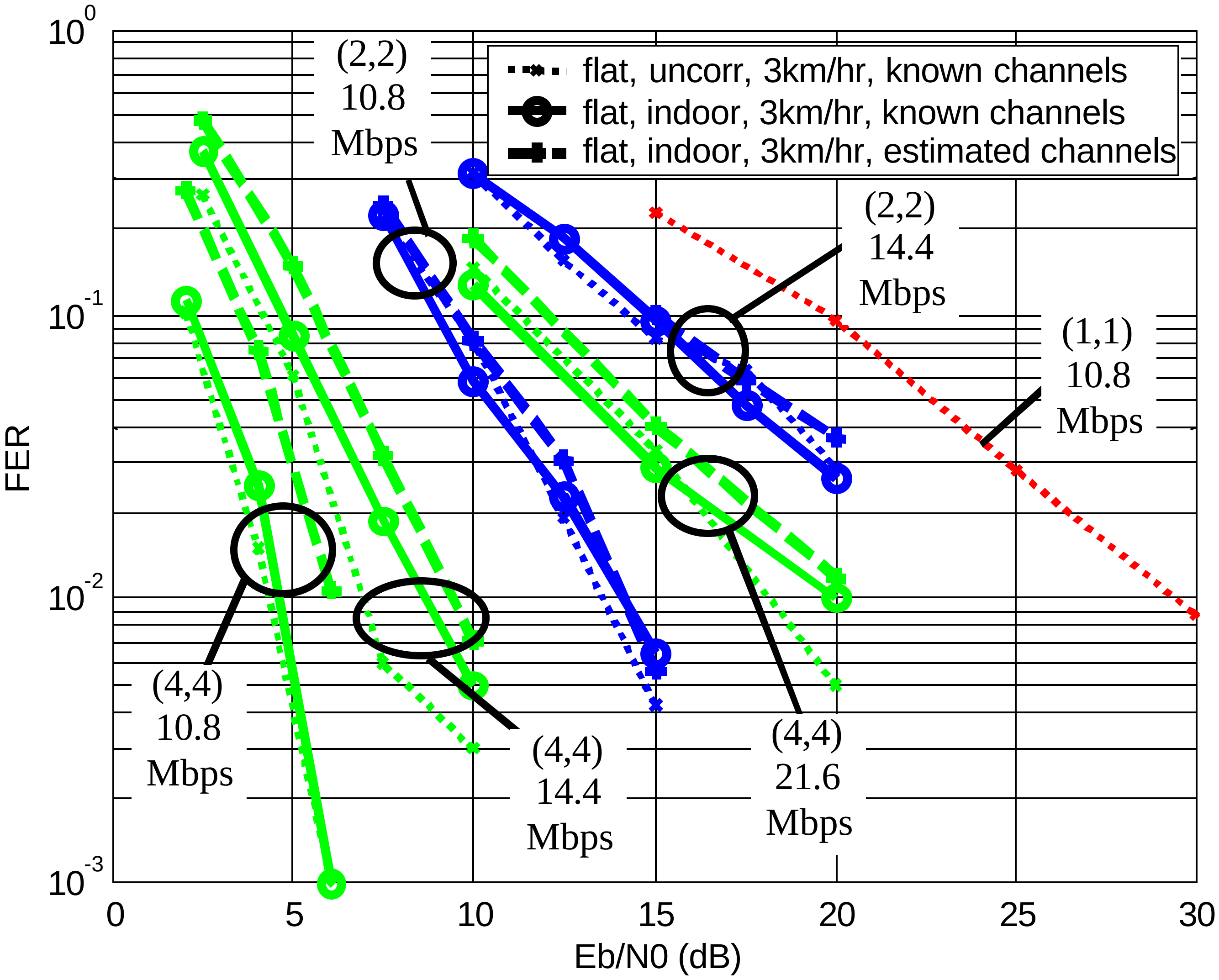
Indoor channel, 3km/hr



Conclusions

- We simulated a MIMO system for HSDPA to measure FER versus Eb/N0.
- We considered faster doppler frequencies, correlated channels, and channel estimation.
- The MIMO system is relatively robust against these impairments and provides significant gains compared to single antenna systems.
- Future work: frequency selective channels.