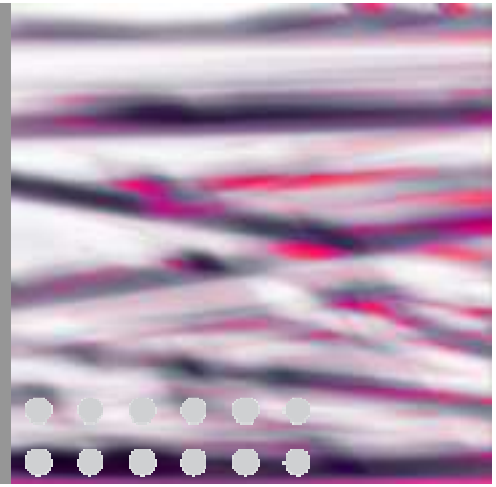
Open Loop versus Closed Loop Performance in LTE



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Agenda

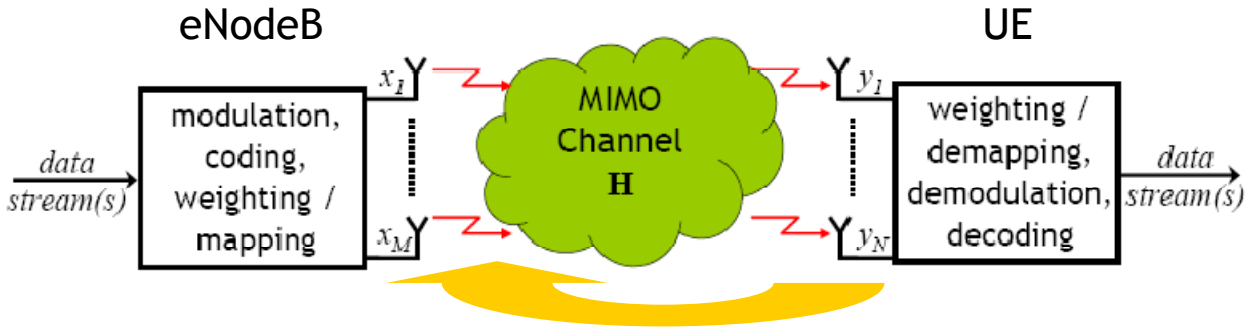
1. Open And Closed Loop Transmission in LTE
2. Physical Layer Results
3. System Level Performance
4. Conclusion

1 Open And Closed Loop Transmission in LTE

Pilot Feedback: PMI, CQI, Rank

SFBC and PARC, TX-Diversity (Closed Loop) and PSRC

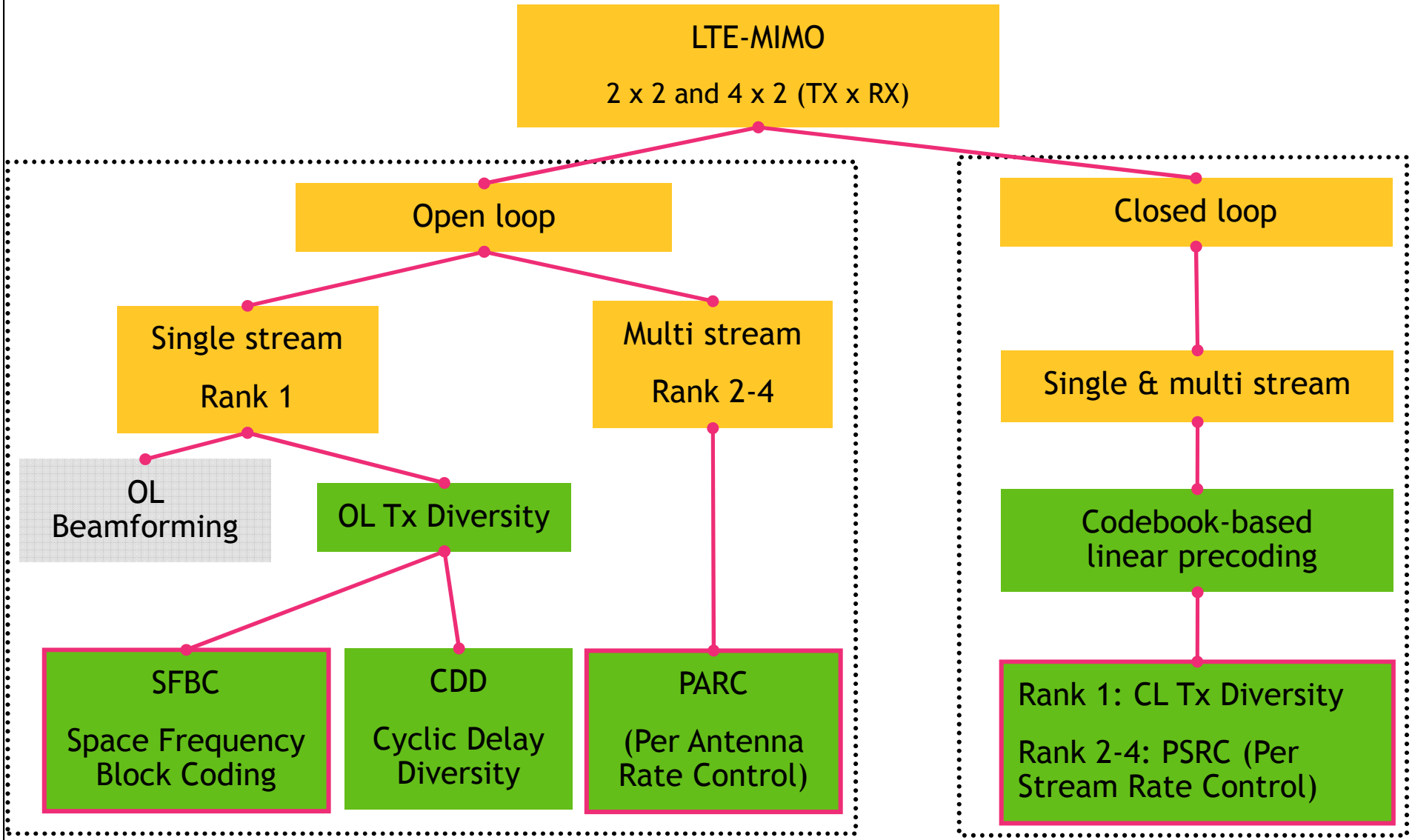
Pilot Feedback



Uplink feedback: PMI, CQI, Rank

		Comment	Freq. Resolution	Available in open loop	Available in closed loop
PMI	Prefered precoding matrix indicator	Index of best Tx weight	Subband	-	X
CQI	Channel quality indicator	Supported transport format	Subband	X	X
Rank		No. of spatial streams supported	Full band	X	X

Downlink MIMO Modes



Comparing Downlink MIMO Modes

Single Stream

- OL SFBC

  Uses diversity by orthogonally transmitting one data stream over two transmit antennas, to reduce dynamic of the received power.

- CL Tx Diversity

  Tries to maximize the received power at the mobile by applying precoding (based on PMI feedback). Sends correlated symbols on transmit antennas.

Dual Stream

- OL PARC

  Uses diversity to transmit two data streams over two transmit antennas.

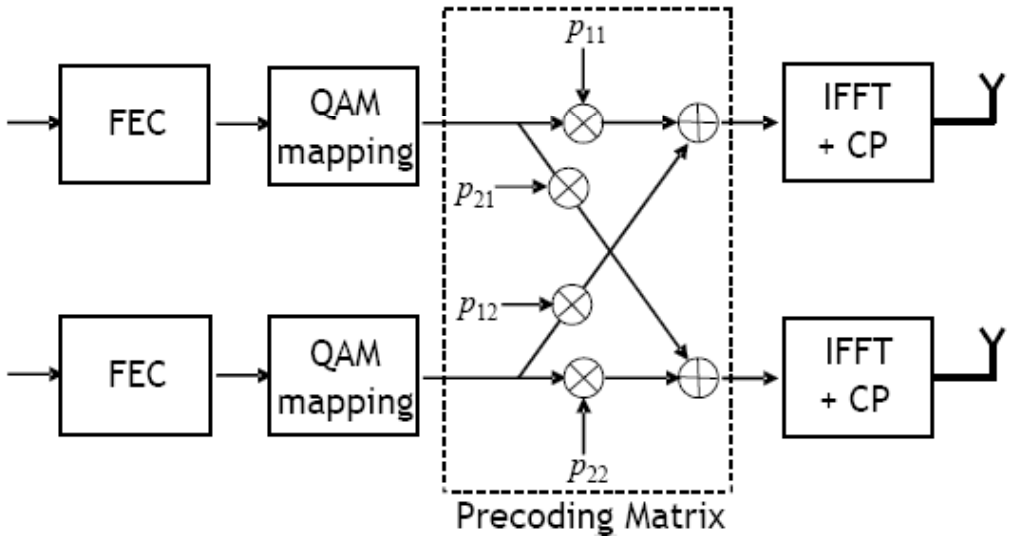
- CL PSRC

  Uses diversity to transmit two data streams over two transmit antennas.

  Tries to maximize the received signal quality of the data streams at the mobile by applying precoding (based on PMI feedback).

Linear Precoding (for PARC, PSRC and CL Tx Diversity)

- Complex linear transmit antenna weights
- Distributes data streams over the antennas
- 2 Tx with 2 layers example for OFDM:



Codebook index	Number of layers υ	
	1	2
0	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\1\end{bmatrix}$	$\frac{1}{\sqrt{2}}\begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}$
1	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-1\end{bmatrix}$	$\frac{1}{2}\begin{bmatrix}1 & 1\\1 & -1\end{bmatrix}$
2	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\j\end{bmatrix}$	$\frac{1}{2}\begin{bmatrix}1 & 1\\j & -j\end{bmatrix}$
3	$\frac{1}{\sqrt{2}}\begin{bmatrix}1\\-j\end{bmatrix}$	-

R8 codebook for 2 Tx

(3GPP TS 36.211)

2 Physical Layer Results

Open Loop Single Layer

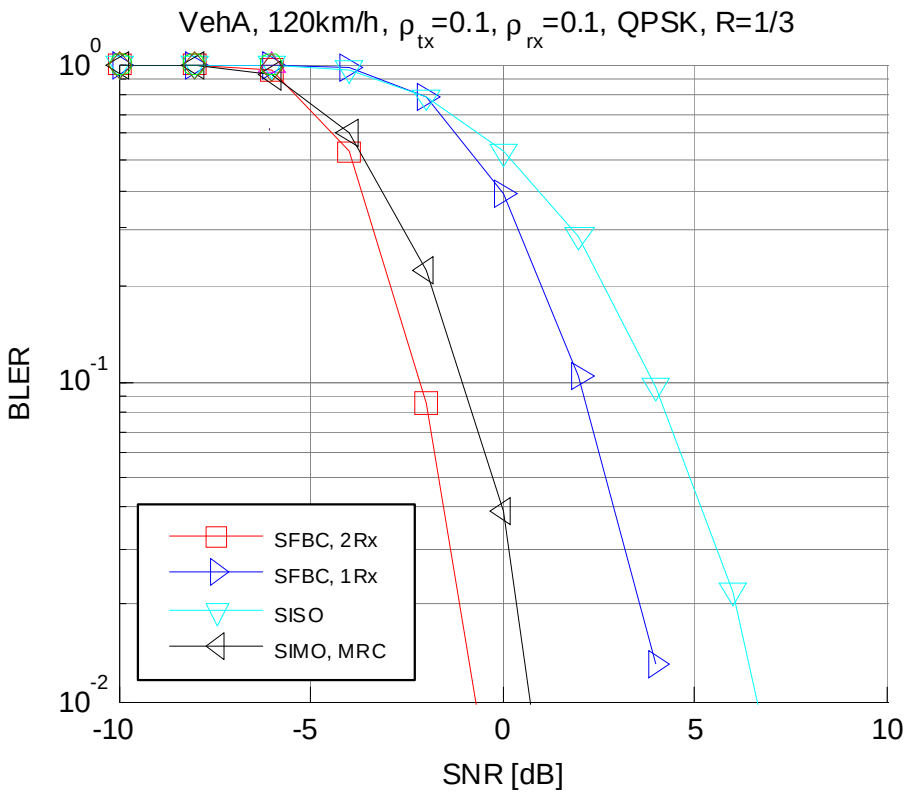
SFBC 2x1, 2x2 versus Single Antenna 1x1, 1x2

Legend:

- SFBC, 1RX: SFBC 2x1
- SFBC, 2Rx: SFBC 2x2
- SISO: 1x1
- SIMO: 1x2

Gain of SFBC at BLER = 0.1:

- SFBC 2x2 is 1.1dB better than 1x2.
- SFBC 2x1 is 1.8dB better than 1x1.



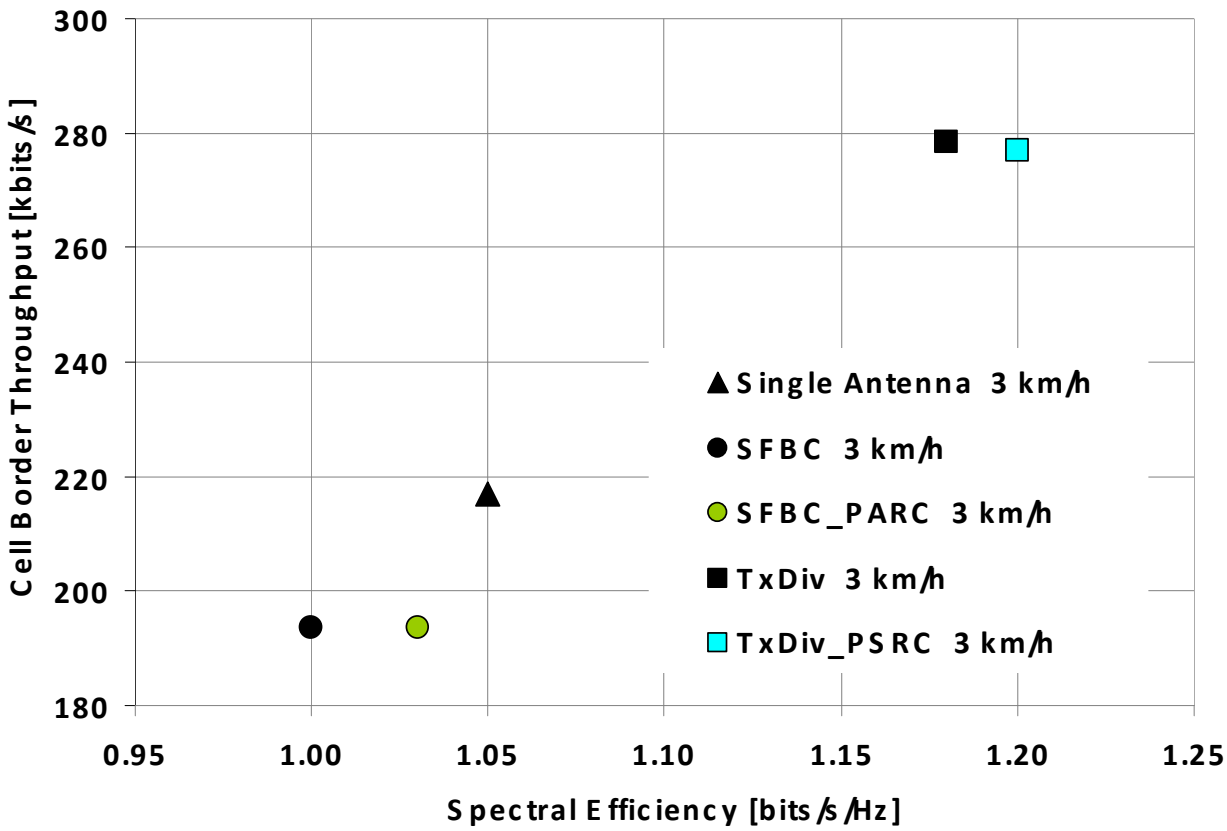
3 System Level Performance

Open Loop and Closed Loop Single/Dual Layer

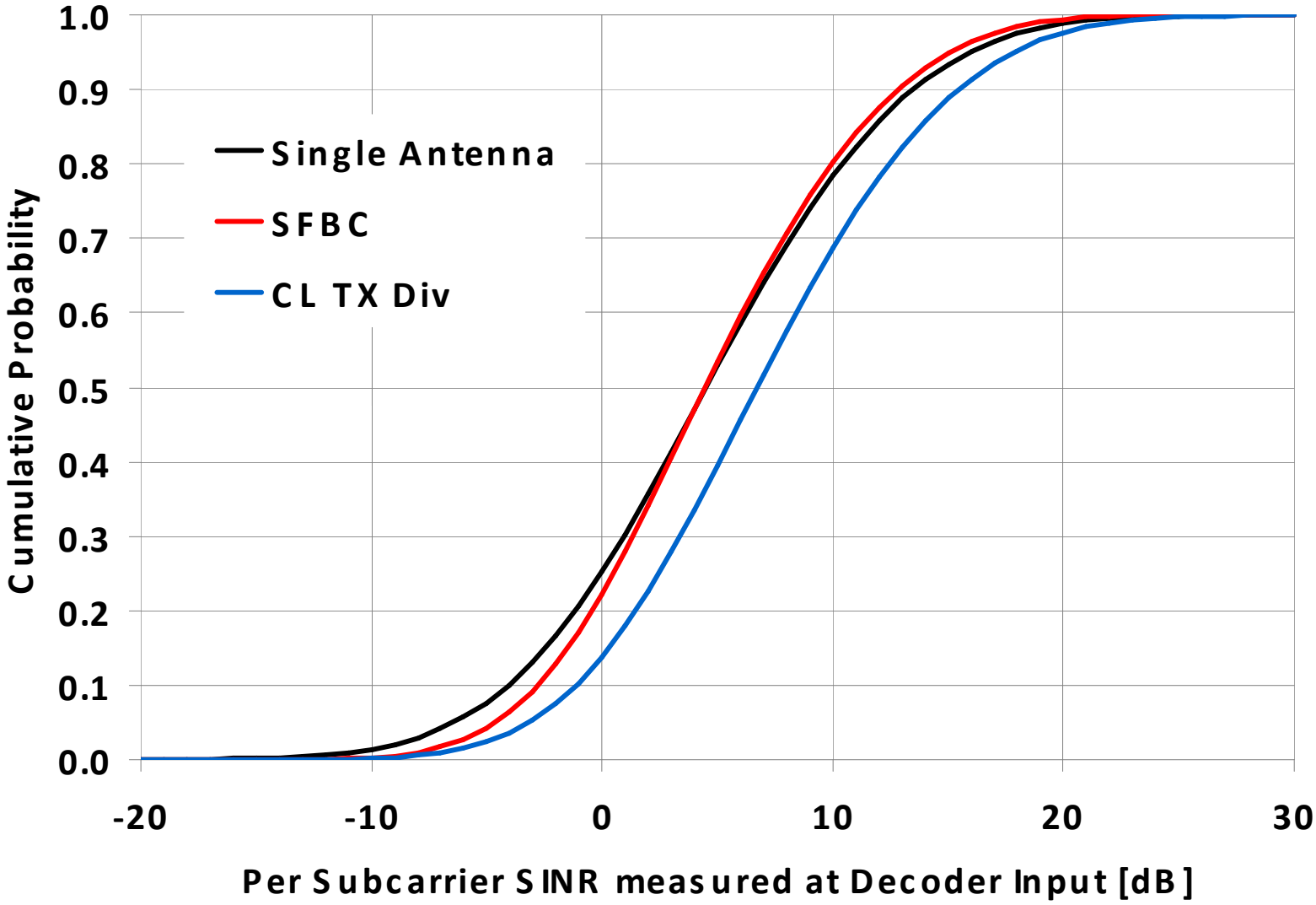
Cell border throughput over spectral efficiency 3km/h

Simulation Assumptions:

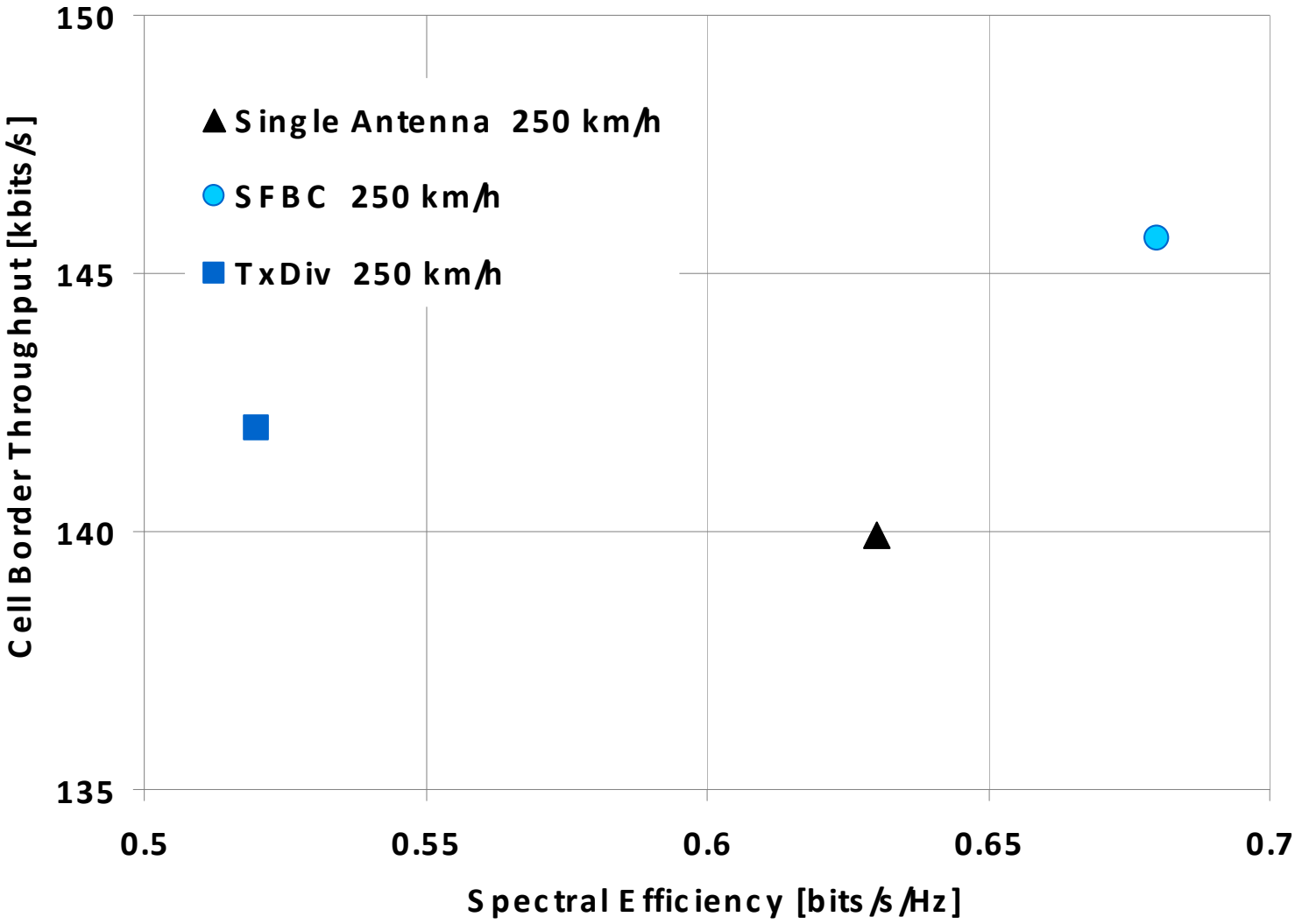
- 210 UEs in 21 sectors
- ISD 500m
- 46dBm per Antenna
- 10MHz bandwidth
- Round Robin Scheduler
- Single Antenna 1x2
- SFBC 2x2
- CL Tx Diversity 2x2



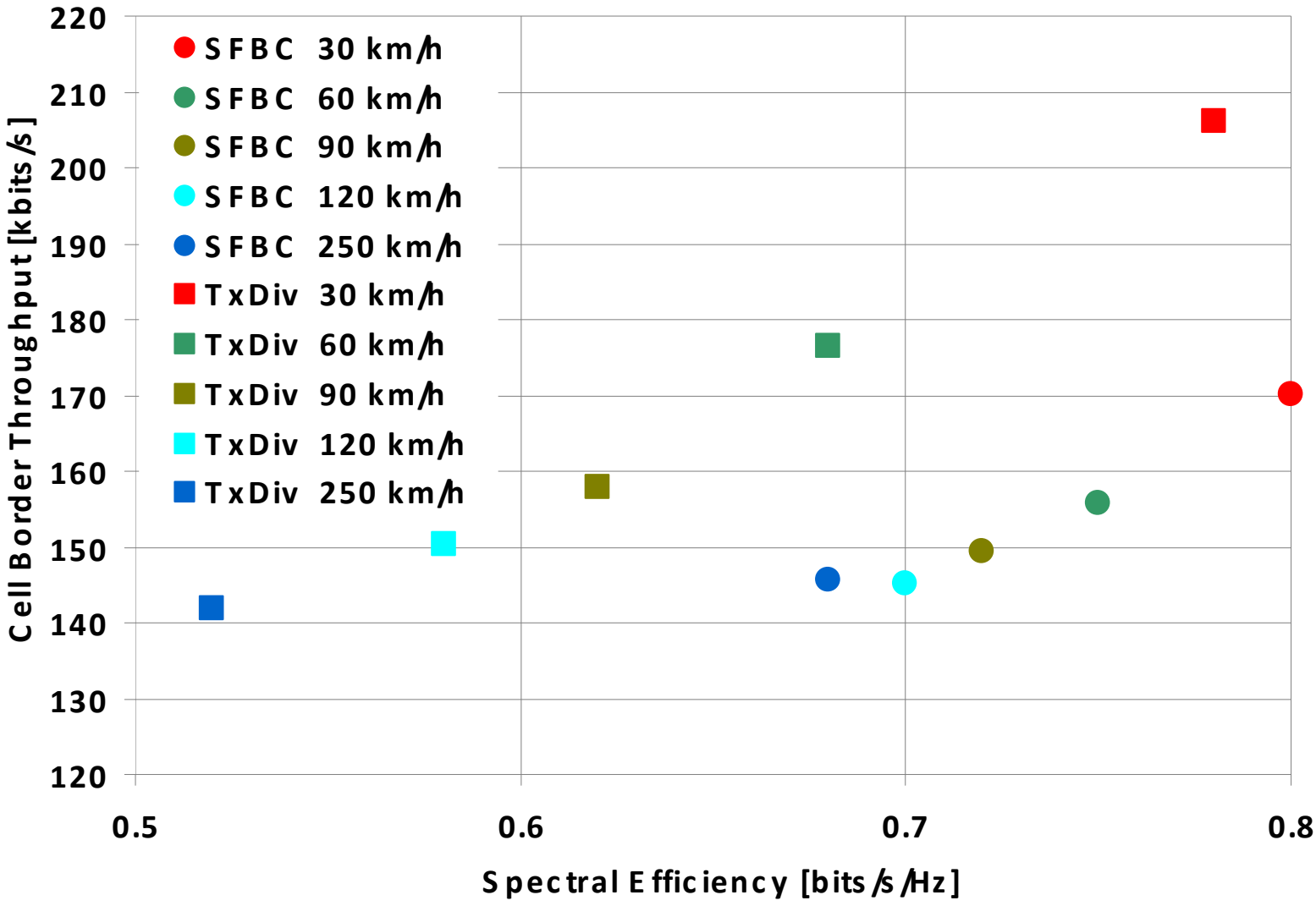
Cumulative Probability of SINR



Cell border throughput over spectral efficiency 250km/h



SFBC versus CL Tx Diversity



4 Conclusion

Conclusion

- SFBC gains from physical layer simulation couldn’t be retrieved in system level simulation.
- Especially at low speed, a transmission technique with higher channel quality variance (with the same mean quality) handles more throughput. This is due to the non linear mapping of channel quality and throughput.
- Frequency selective schedulers, which can take advantage of situations with high SINR, promise to improve system performance even more.
- With a round robin scheduler and velocities higher than 30 km/h, SFBC becomes attractive as a fallback mode for closed loop transmit diversity.

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