Link level results for HSDPA using multiple antennas in correlated and measured channels

Lucent Technologies

RAN WG1 #19, La$ Vegas USA

Overview

- **Microcell model for spatially correlated channels (from Siemens)**
- **Channel model from measured data (from midtown Manhattan)**
- **Link level results**

Microcell channel model from Siemens (channel C)

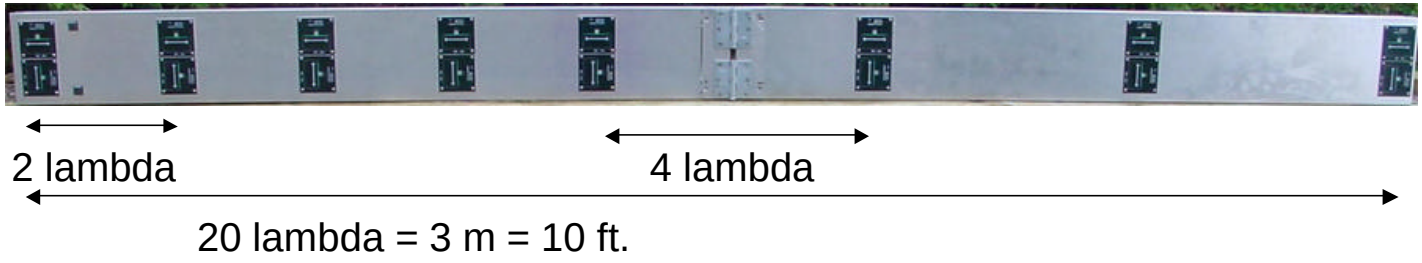
- **Linear Node B transmit array**
  - **0.7 wavelength antenna spacing**
  - **45 degree angular spread**
- **Linear UE receive array**
  - **0.5 wavelength antenna spacing**
  - **360 degree angular spread**

Overview for using channel measurements

- **Several million channel matrices were measured in midtown Manhattan (dense urban environment).**
- **Shannon capacities computed based on measurements.**
- **A representative set of contiguous channels corresponding to the median capacity was selected.**
- **Channel correlations are computed from this set.**
- **MIMO link level simulations are run based on these correlations.**

Transmitter

- **2x8 transmitter array of patch antennas with 2 polarizations.**
- **Carrier frequency 2.11 GHz, 16 tones each separated by 2KHz.**
- **Transmitter placed on a 38th floor balcony of New Yorker Hotel in midtown Manhattan.**
- **Transmit power per antenna is 23dBm.**



LEGEND
SMA coax cable or connector

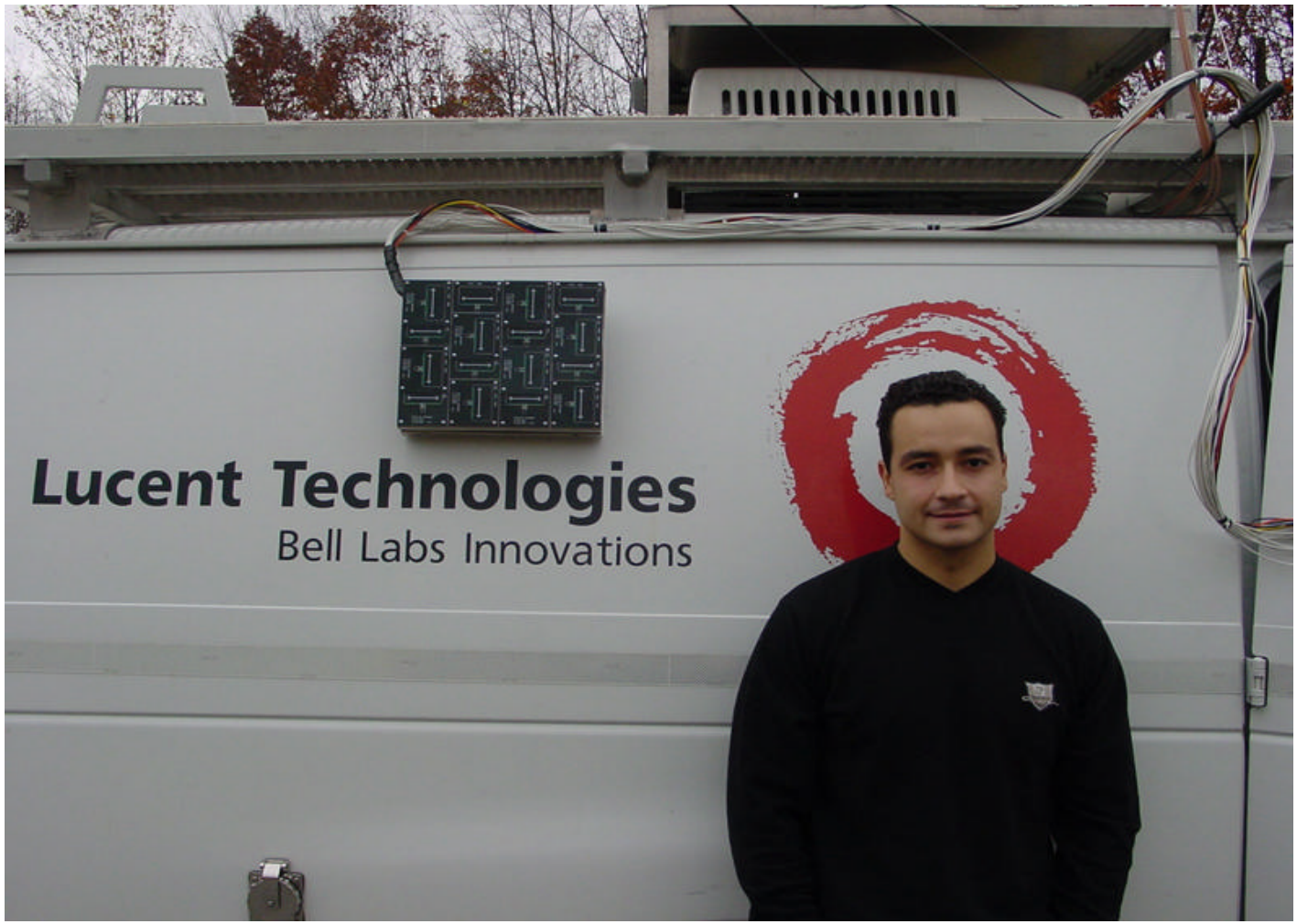
Transmitter's view from balcony

Receiver

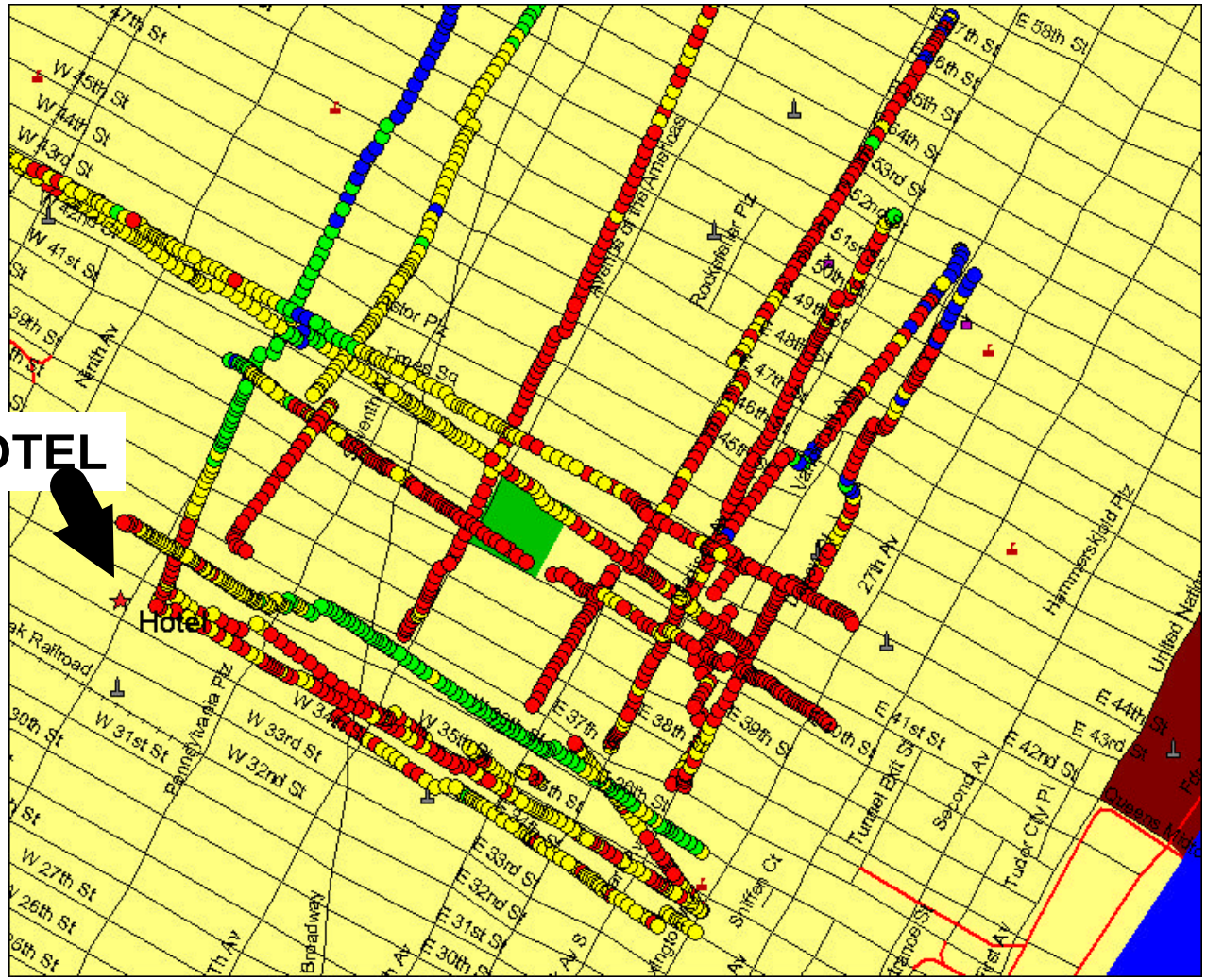
- 4x4 receiver array of patch antennas with 2 polarizations.
- 1/2 wavelength element spacing.
- Placed on side of van at height of 2m.
- 12 bit A/D converters for each channel coefficient.
- One channel realization is a 256 = 16x16 complex matrix of coefficients.
- One channel realization measured each 1.5 ms.
- Received SNR is at least 20dB to ensure sufficient accuracy.

LEGEND
→ SMA coax cable or connector

Receiver on measurement van



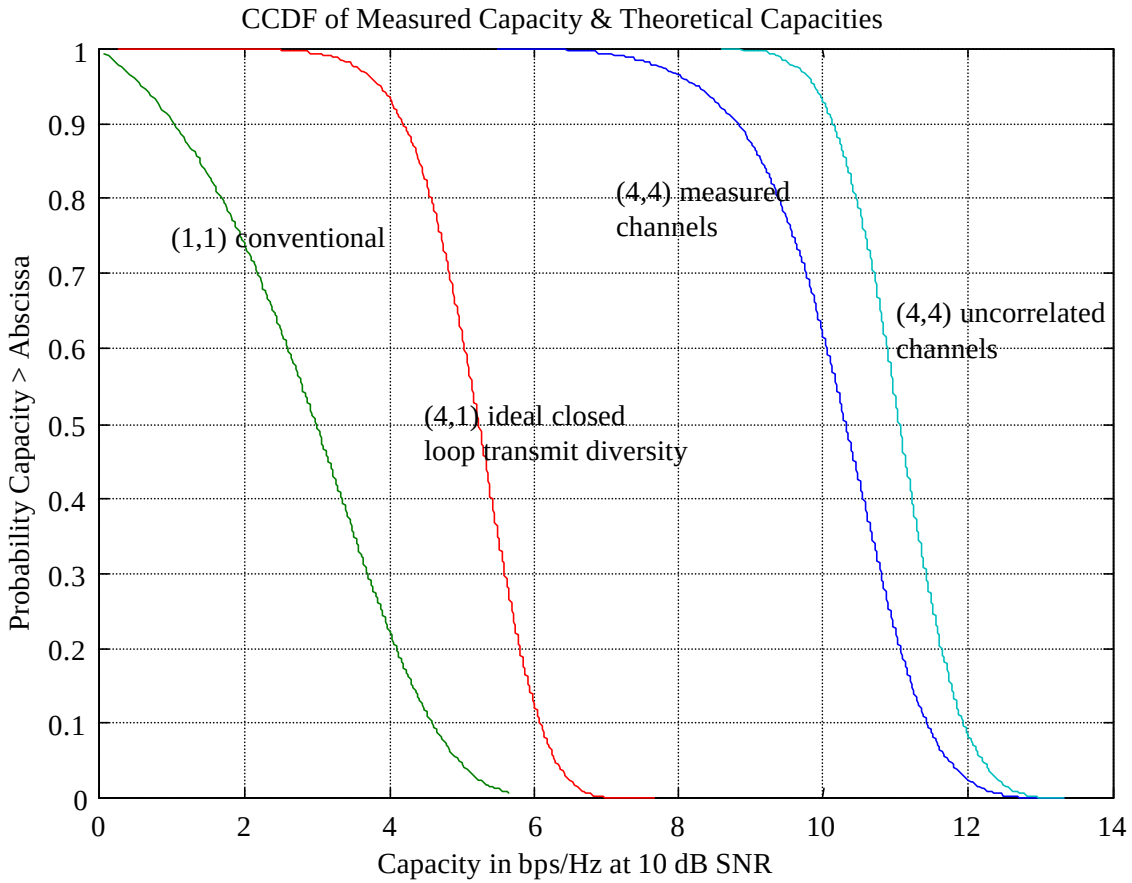
Drive route and capacity



- **16Tx 16 Rx**
- **20 dB System SNR**
  >20 dB Measured SNR
- **1 Mile Range**

- **RED Very High**
  70 to 88 bps/Hz
- **YELLOW High**
  50 to 70 bps/Hz
- **GREEN Med.**
  30 to 50 bps/Hz
- **BLUE Low.**
  10 to 30 bps/Hz

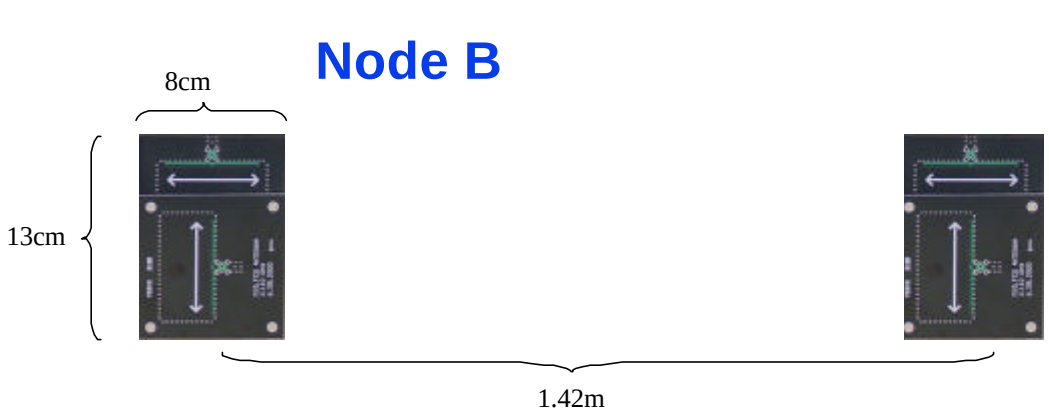
Shannon capacity for (4,4) MIMO

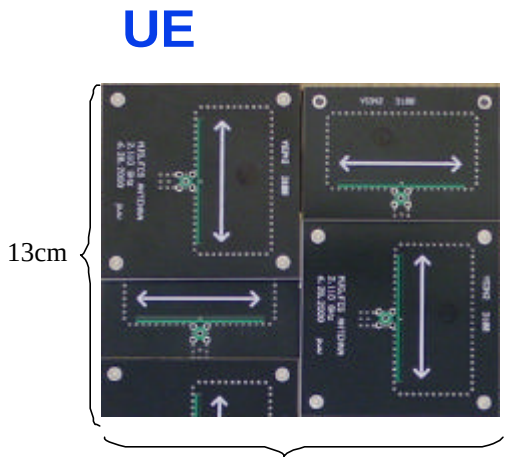


- **CDF is of entire dataset**
- **Measured capacity is 90% of ideal capacity.**

Deriving channel correlations from measurements

- **Chose a contiguous series of 68 channel matrix realizations corresponding to the median (4,4) Shannon capacity.**
- **Compute the channel correlations based on these realizations for 10 wavelength Node B antenna spacing and square configuration UE antennas.**





Channel parameters

	Microcell "channel C"	Measured urban channel
Node B antenna spacing	0.7w	10w
UE antenna spacing	0.5w	0.54w
Avg. cross-corr (2,2)	0.39	0.05
Max. cross-corr (2,2)	0.67	0.11
Avg cross-corr. (4,4)	0.20	0.17
Max cross-corr. (4,4)	0.67	0.77

w = wavelength (about 15cm at 2GHz)

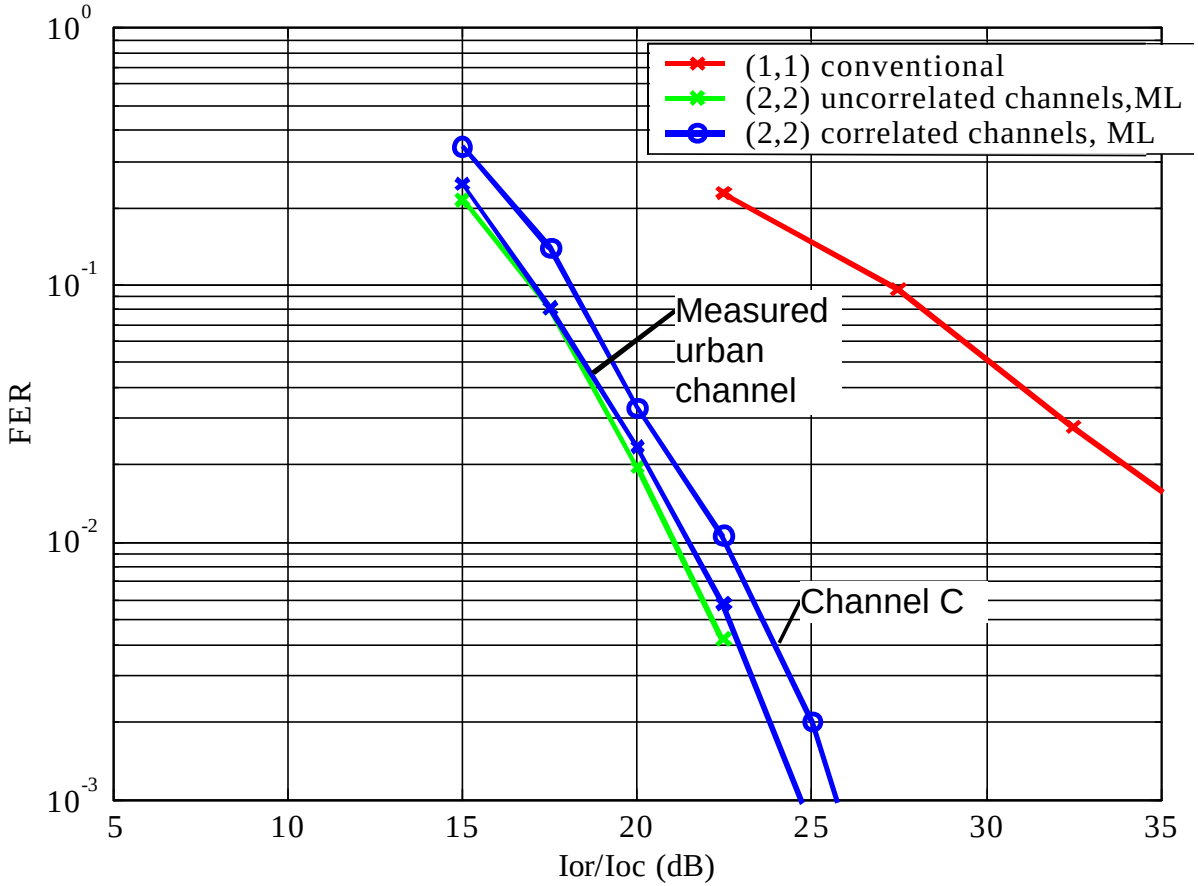
Link simulation assumptions

- **Transmission techniques:**

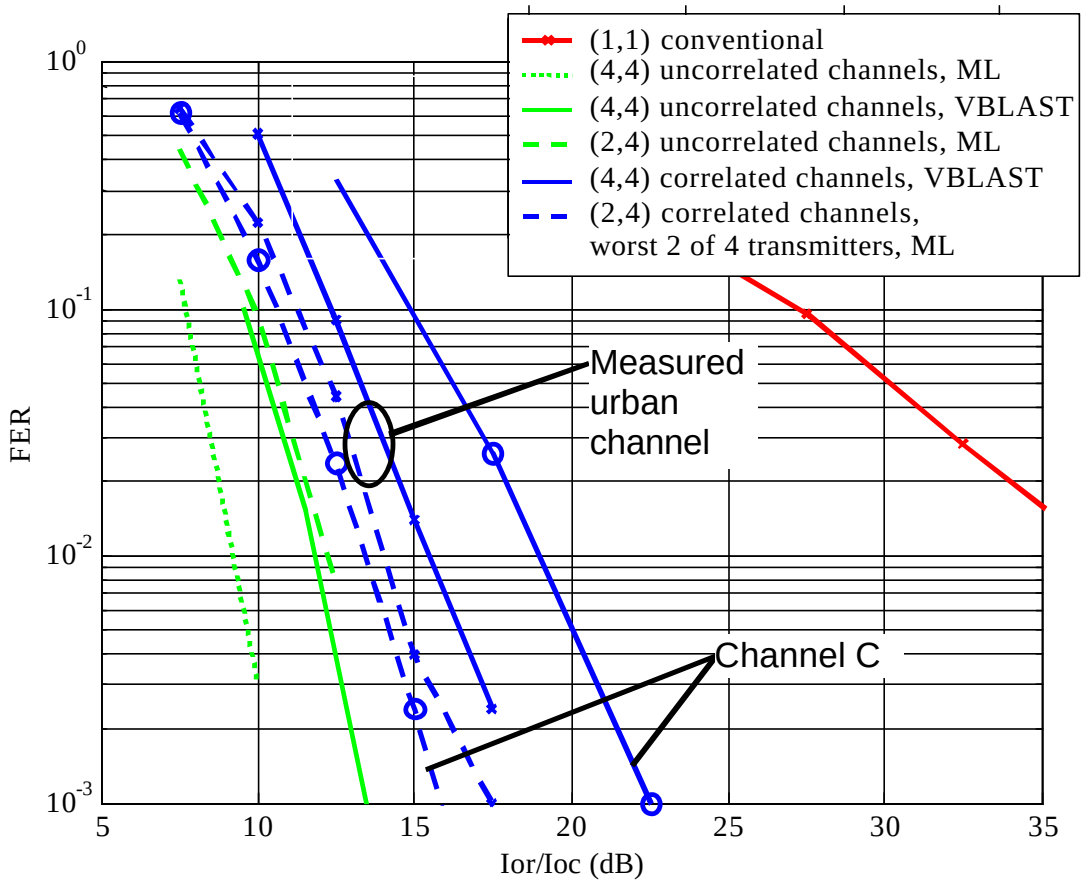
TX Antennas	Modulation	Code rate	Data rate
1	64QAM	3/4	10.8Mbps
2	8PSK	3/4	10.8Mbps
2	16QAM	3/4	14.4Mbps
4	4PSK	~1/2	10.8Mbps
4	4PSK	3/4	14.4Mbps

- **Flat fading channel, 3km/hr**
- **Ideal channel estimation**

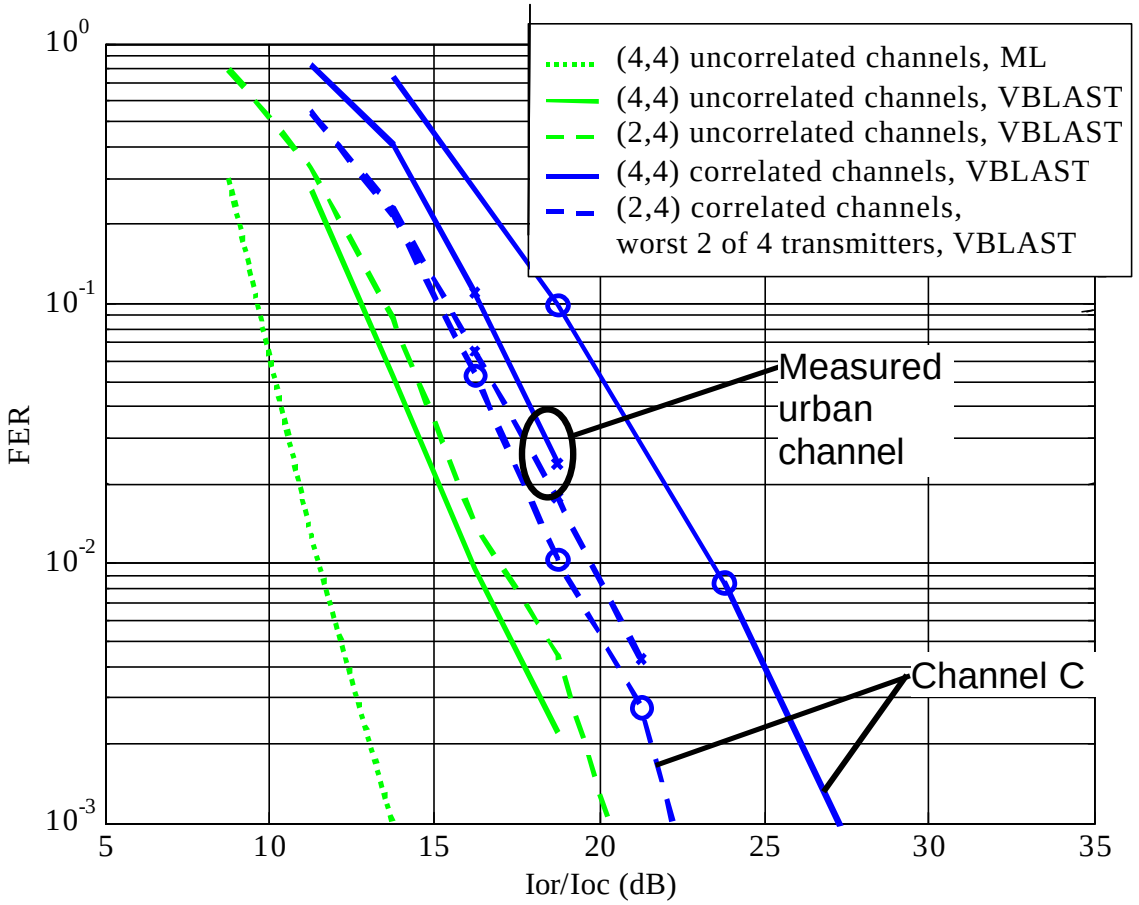
Two antenna receivers, 10.8 Mbps



Four antenna receivers, 10.8 Mbps



Four antenna receivers, 14.4 Mbps



Conclusions

- **Effects of microcell channel correlation are not significant.**
- **Effects of correlations derived from initial urban channel measurements are not significant.**
- **Future studies will address**
  - **wideband channels**
  - **suburban channels**
  - **effects of lower antennas**
  - **effects of human body**