TSG-RAN Working Group 1 meeting No. 18 ***TSGR1#18(01)-0103***
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Agenda item:	**AH26: Tx Diversity**
Source:	**Fujitsu**
Title:	**Simulation Results of the Tx Diversity Scheme with Beamforming Feature**
Document for:	**Discussion**

1. Introduction

At the TSG RAN WG1 meeting #15, we proposed a new multiple antenna Tx diversity scheme with a beamforming feature [1]. The proposed scheme supports a variety of antenna configurations and beamforming algorithms to achieve an efficient Tx diversity/beamforming gain depending on the spatial correlation characteristics. According to transmit antenna configuration of the Node B, UE calculates short-term diversity weights and long-term beamforming weights, which are signaled to Node B on the appropriate feedback frame format.

In this contribution, we show some simulation results of our proposed scheme as shown in Figure 1 and compare with other Tx diversity schemes with more than two antenna elements.

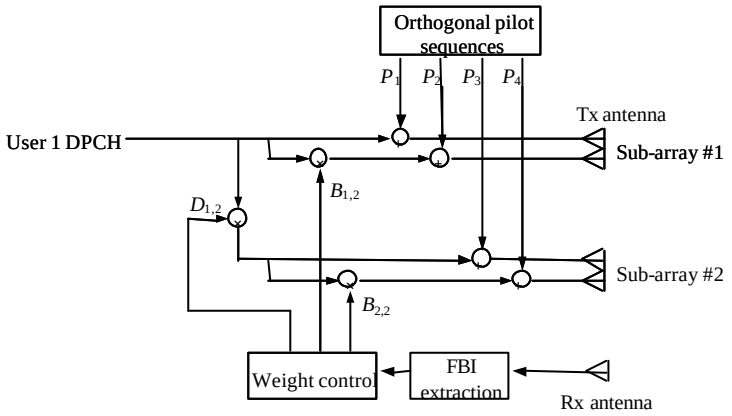

Figure 1. Structure of the combined Tx diversity/beamforming (N=4, M=2)

2. Simulation parameters

Simulation parameters were chosen in accordance with [2] and listed in Table 1. Additional simulation parameters were shown in Table 2.

Table 1. Simulation parameters

Bit Rate	12.2 kbps
Chip Rate	3.84 Mcps

Convolutional code rate	1/3
Carrier frequency	2 GHz
Power control rate	1500 Hz
PC error rate	4 %
PC step size	1 dB per antenna
Channel models and UE velocities	1-path Rayleigh: 3, 10, 40, 120 km/h ITU Ped. A: 3, 10, 40, (120) km/h ITU Veh. A: (3), 10, 40, 120 km/h
CL feedback bit error rate	4 %
CL feedback delay	1 slot
TTI	20 ms
Downlink DPCH slot format	#11
# of RAKE fingers for ITU channel model	5
Target FER/BlkER	1 %
Geometry (G)	-3, 0 and 6 dB
Common Pilot	-10 dB total
Performance measure	T_x E_c/I_{or}
CL feedback rate	1500 Hz

Table 2. Additional simulation parameters

Channel estimation	from CPICH with ideal weight verification
CPICH Correlation between antennas	equal power allocation for each Tx antenna 0: between diversity branches 1: among each sub-array
UE location	preserving 0 degree direction from Node B
Multipath angular spread	0 degree
Beamforming resolution	45 degree

The following frame format for the feedback information bits was used for the proposed scheme. Single beamformer weight is quantized by 3 bits and feeds back in a frame to Node B.

Table 3. Multiplexing format of feedback information

Slot #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
FB bits for D	1	1	1	1	0	1	1	1	1	0	1	1	1	1	0
FB bits for B	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1

3. Simulation Results

Five different antenna schemes were simulated and compared as follows.

- **1 Ant.**
  - Number of Tx antennas = 1
  - Without closed loop Tx diversity
- **2 Ant. Mode 1**
  - Number of Tx antennas = 2
  - Closed loop Tx diversity Mode 1 (Release'99)

- **4 Ant. Mode 1**
  - Number of Tx antennas = 4
  - Extension of closed loop Tx diversity Mode 1
- **2x2 Ant. Mode 1**
  - Number of Tx antennas = 4 (two-sub-array configuration)
  - Extension of closed loop Tx diversity Mode 1
- **2x2 Ant. BF**
  - Number of Tx antennas = 4 (two-sub-array configuration)
  - Proposed weight adaptation, see Table 3

Simulation results are shown in Figure 2–6.

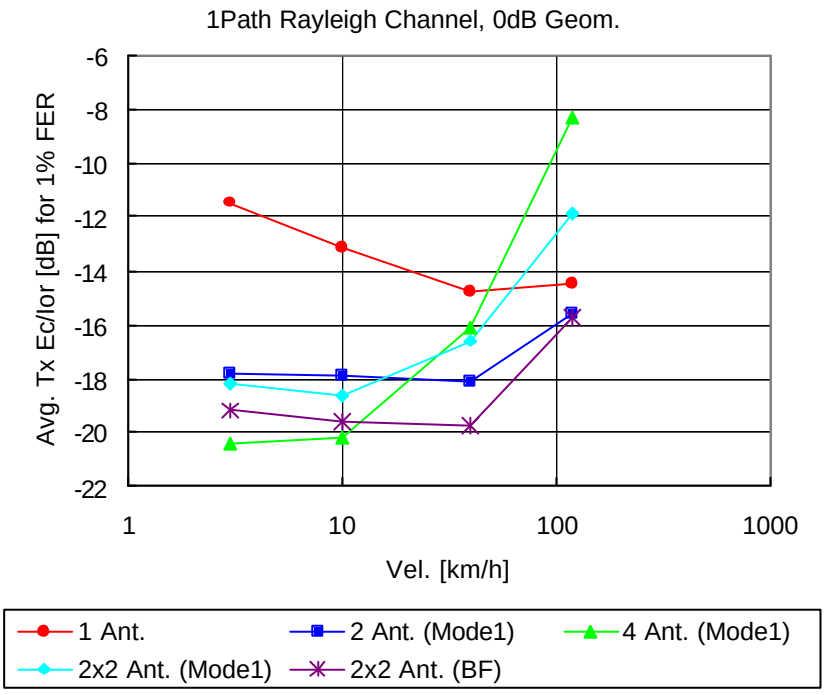

Figure 2. 1 path Rayleigh channel, 0 dB geometry.

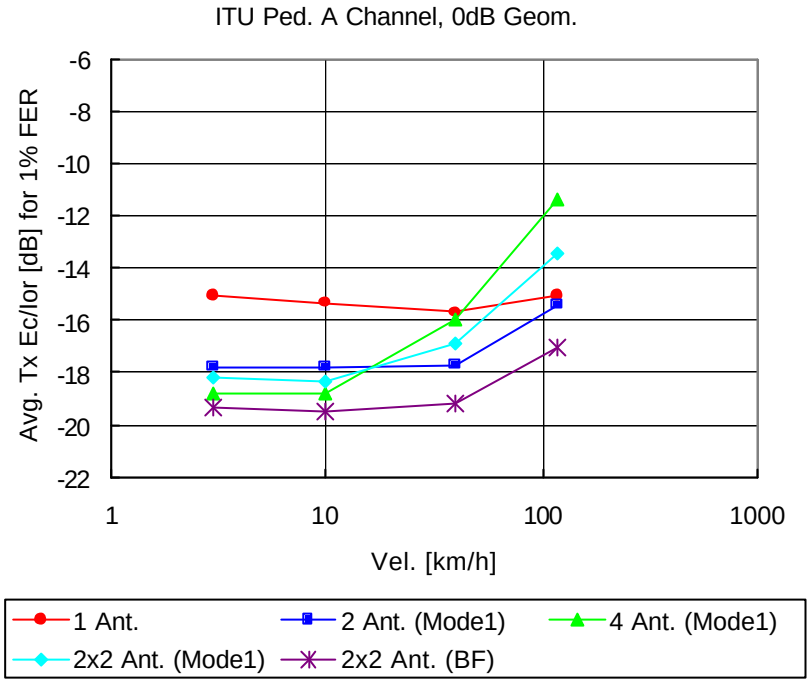

Figure 3. ITU Pedestrian A channel, 0 dB geometry.

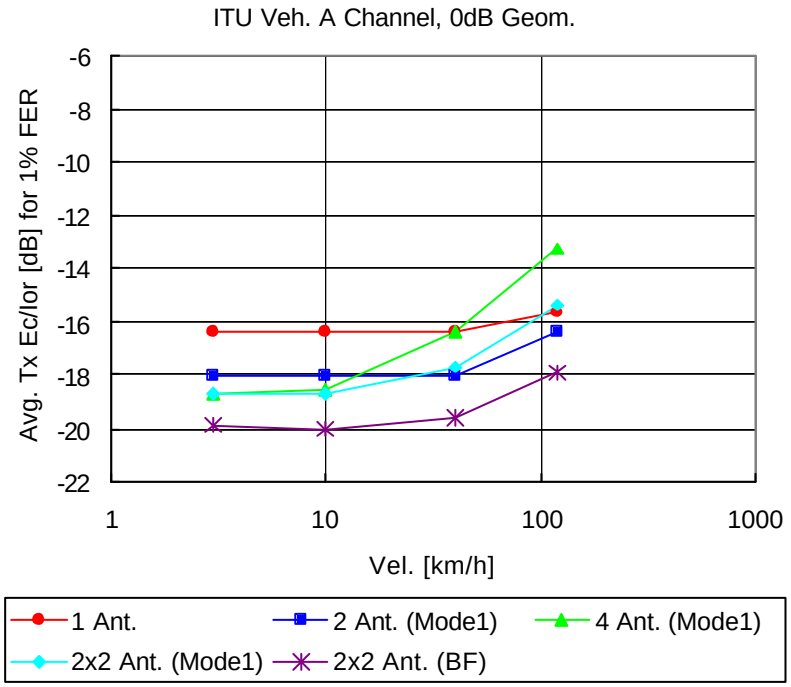

Figure 4. ITU Vehicular A channel, 0 dB geometry.

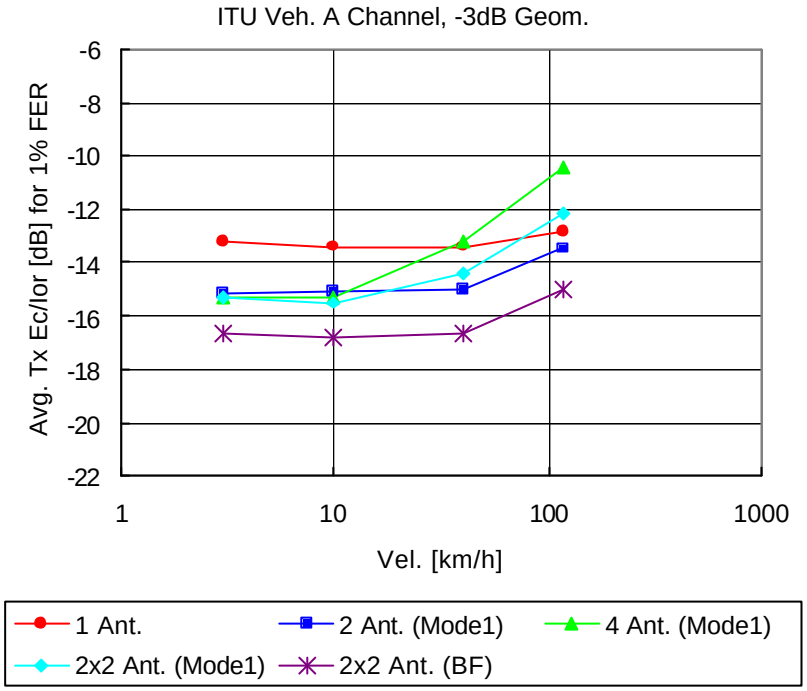

Figure 5. ITU Vehicular A model, -3 dB geometry.

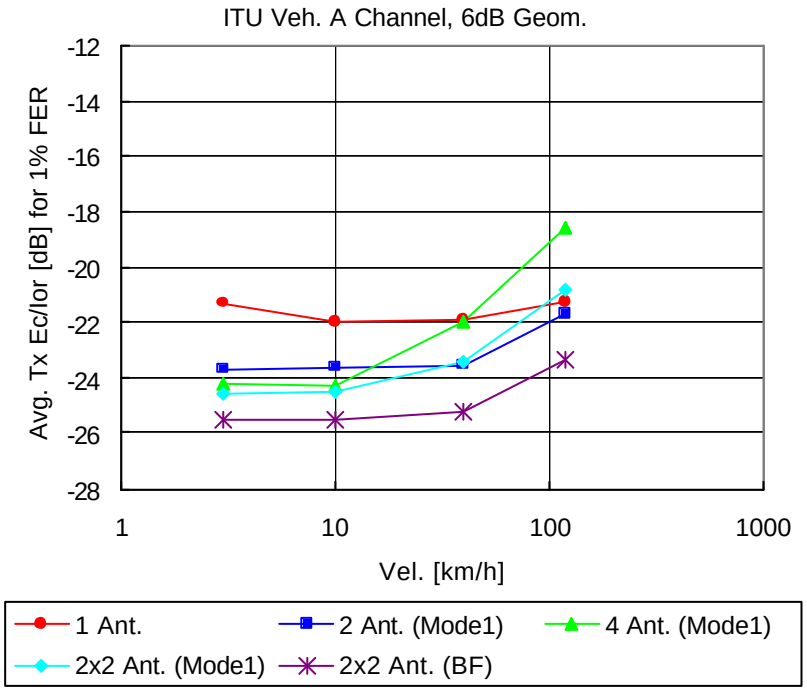

Figure 6. ITU Vehicular A model, 6 dB geometry.

4. Summary

This document showed some initial simulation results of the proposed multiple antenna Tx diversity scheme with sub-array antenna configuration. Following conclusions can be drawn from the simulation results presented:

- Simple extension of Tx diversity Mode 1 rapidly degrades the performance in the high mobility region due to the limited feedback bandwidth.
- Proposed scheme combining Tx diversity and beamforming improves the performance regardless of UE mobility. Average Tx Ec/Ior can be reduced about 1.8–2.0 dB.
- Beamforming gain of the proposed scheme is independent of channel model and geometry.

The advantages of the proposed Tx diversity scheme with beamforming feature are summarized in the following:

- The proposed scheme will not particularly increase the amount of feedback information which maintains good performance in fast fading conditions.
- The beamforming gain increases in proportion to the number of antenna elements, while the achievable net diversity gain will be less significant. Tx diversity gain of 2-branch seems to be sufficient due to the additional Rx diversity gain.
- The sub-array configuration is applicable and shows good performance in both uplink and downlink.
- Downlink Beamforming reduces the interference to the other UEs and improves the channel capacity.
- Unequal power allocation for pilot sequences of CPICH can minimize the channel estimation performance degradation for the Release'99 UEs.
- Significant specification revision may not be required in the case increasing the number of beamformer elements.
- Physical antenna space will not increase when 2-branch diversity system is already used.
- The complexity impact to UE is relatively small.

Further study may be necessary to investigate the condition including UE mobility and practical spatial correlation between antenna elements. Unequal power allocation for pilot sequences of CPICH should be subject for further study.

References

[1] Fujitsu. Enhance the beamforming feature of the multiple antenna Tx diversity. TSG-R WG1 document, TSGR1#15(00)1065, 22-25, August, 2000, Berlin, Germany.

[2] Nokia. Recommended simulation parameters for Tx diversity simulations. TSG-R WG1 document, TSGR1#14(00)0867, 4-7, July, 2000, Oulu, Finland.