Meeting #15
22-26th, August, 2000
Berlin, Germany

Agenda Item :	7
Source :	Motorola
Title :	Verification algorithm for closed loop transmit diversity mode 2
Document for :	Discussion

Introduction

The RAN1 specifications currently contain an example verification algorithm for transmit diversity mode 1. Although, the example algorithm only applies to mode 1, the general principle of verification can be extended for transmit diversity mode 2.

This document describes a general verification algorithm for transmission diversity mode 2. Simulation results are given in order to compare the performance of mode 2 with and without verification.

1 Generic Extension of verification for mode 2

For the current mode 2 specification, the same pilot sequence is transmitted on both antennas for DPCCH. Therefore, we obtain the equivalent channel estimation which corresponds to the channel seen by the UE receiving antenna (equivalent channel seen by the DPCCH) :

$$\vec{h}^{(d)} = g\,(b_1\vec{h}_1 + b_2\vec{h}_2) + \vec{b}^{(d)} \quad \text{Eqn. (1)}$$

where γ^2 is the DPCCH Pilot SNIR/CPICH SNIR, Signal to Noise plus Interference Ratio and b_1, b_2 are the applied coefficients on the antennas at the UTRAN. Furthermore, in all cases, we have channel estimations made on CPICH Pilots for each antenna:

$$\vec{h}_1^{(p)} = \vec{h}_1 + \vec{b}_1^{\,p} \qquad \text{Eqn (2)}$$

$$\vec{h}_2^{(p)} = \vec{h}_2 + \vec{b}_2^{\,p} \qquad \text{Eqn (3)}$$

where $\vec{h}_i^{(p)}$ is the estimated channel vector using the CPICH, $\vec{h}_i$ is the actual channel vector, and $\vec{b}_i^{\,p}$ is the noise vector, from the *i-th* antenna.

At the receiver, verification consists in choosing a pair of applied coefficients at the UTRAN, $(\hat{b}_1, \hat{b}_2)$, which fits best to the actual applied one (c.f. signaling errors in the annex A in [2]).

One possible way of implementing verification for mode 2 is by choosing $(\hat{b}_1, \hat{b}_2)$ from the whole set of possibilities $T = \{a_1, a_2\}$, using the logarithmic form, of the following decision rule:

$$(\hat{b}_1, \hat{b}_2) = \arg\left\langle \max_{a_1, a_2 \in T} \left\{ \ln(\hat{p}(a_1, a_1)) + \ln(\bar{p}(a_1, a_2)) \right\} \right\rangle \quad \text{Eqn. (4)}$$

where , in normal operation the *a priori* probability $\bar{p}(a_1, a_2)$ for the selected antenna coefficients pair (asked word at the UE) is assumed to be 96% (assuming there are 4% of errors in the feedback channel).

$$\ln(\hat{p}(\hat{b}_1,\hat{b}_2)) = -\left(\sum_{i=1}^{Npath}\frac{\left|h_i^{(d)} - g\left(\hat{b}_1 h_{1,i}^{(p)} + \hat{b}_2 h_{2,i}^{(p)}\right)\right|^2}{s_i^2\left(1+g^2\left(\left|\hat{b}_1\right|^2+\left|\hat{b}_2\right|^2\right)\right)}\right) \quad \text{Eqn. (5)}$$

2 Simulations assumptions

Parameter	Explanation/Assumption	
Service	Speech 12.2 kbps	
Chip Rate	3.84 Mcps	
Closed loop Power Control	OFF	
Channel Estimation	PILOT ; DPCCH if verification OFF , CPICH if verification ON	
FBI error rate	0%, 4%,and 10%	
Number of samples per chip	1	
FBI rate	1500 bps	
Propagation Conditions	ETRP A, ETRV A	
Number of Rake Fingers	2 for ETRP and 4 for ETRV	
Downlink Physical Channels and Power Levels	CPICHP_Ec1/Ior	= -13 dB
	CPICHP_Ec2/Ior	= -13 dB
	PCCPCH_Ec1/Ior	= -15 dB
	PCCPCH_Ec2/Ior	= -15 dB
	PICH Ec/Ior	= -15 dB
	SCH_Ec/Ior	= -12 dB (Combined energy of Primary and Secondary SCH)
$\hat{I}_{or} / I_{oc}$ value	6 dB	

Table 1. Simulation parameters

3 Simulation results for mode 2 with verification

The following figures show the performance of the generic verification algorithm for transmission diversity mode 2. The performance is shown for the following channel models:

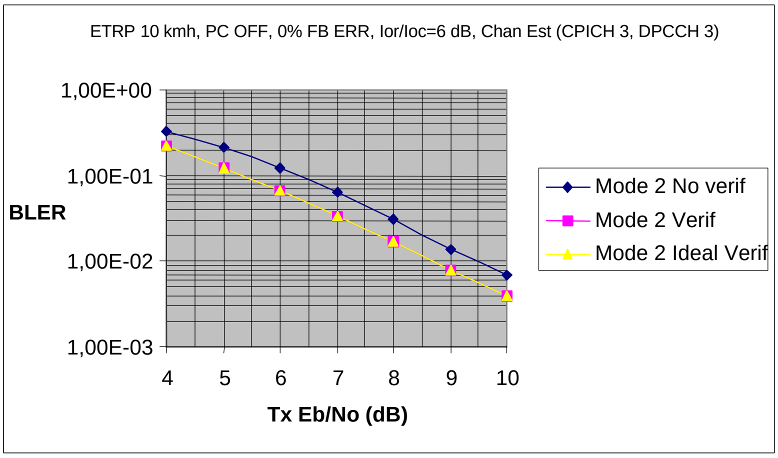
- ETRP, 10km/h
- ETRP, 20km/h
- ETRV, 50km.h

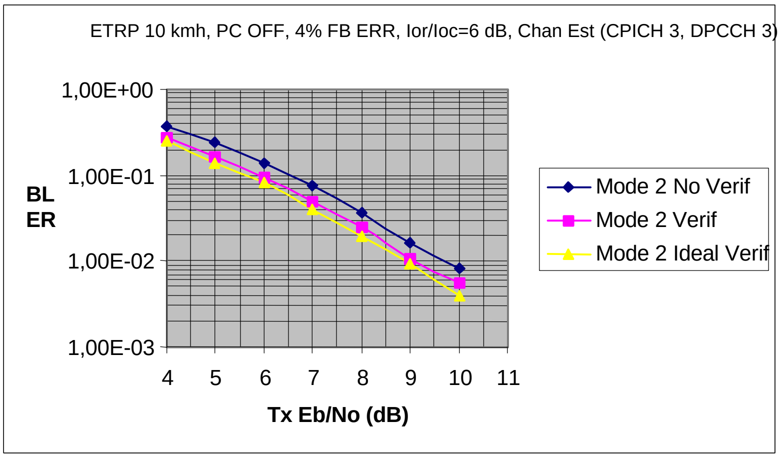
and for the following feedback error rates:

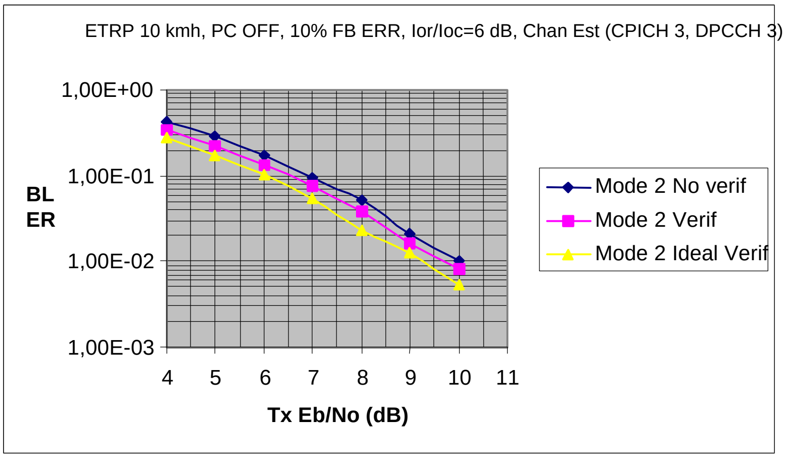
- 0%
- 4%
- 10%

At a BLER of 10^{-2} and for a nominal feedback error rate of 4%, verification for mode 2 gives a gain of 0.7dB for all of the channel models considered.

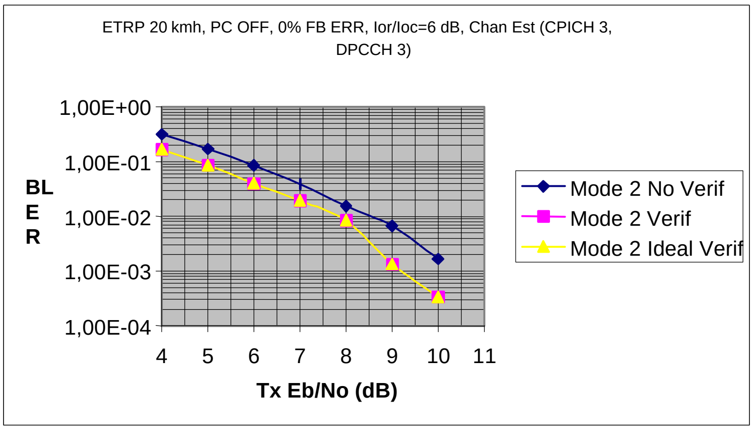
3.1 Performance for ETRP A 10 km/h

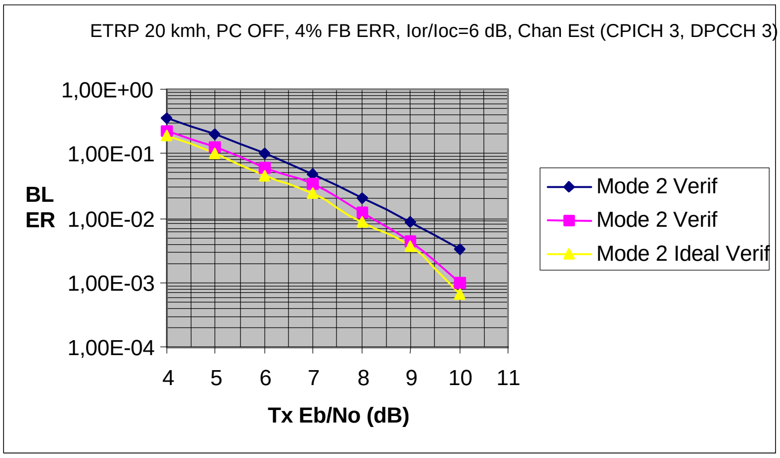


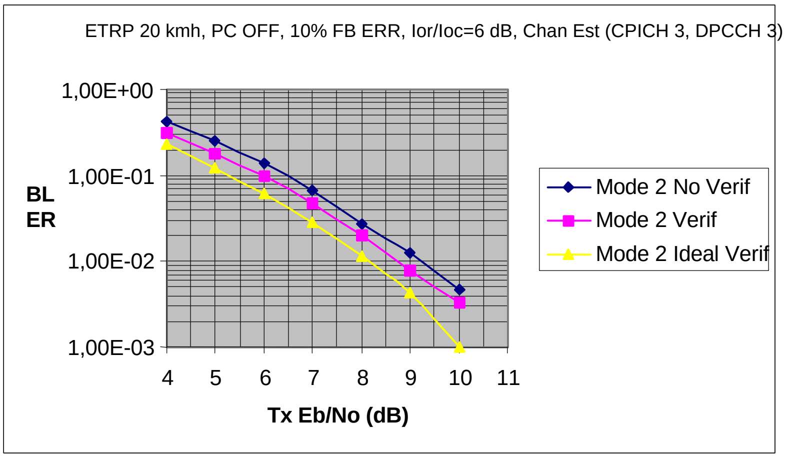




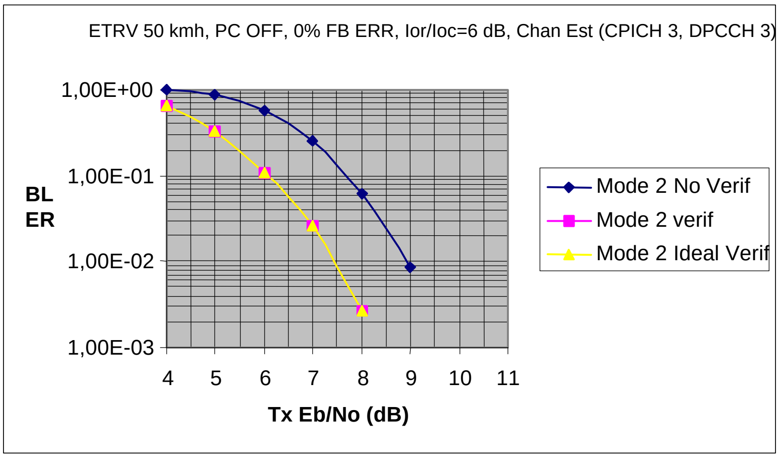
3.2 Performance for ETRP A 20 km/h

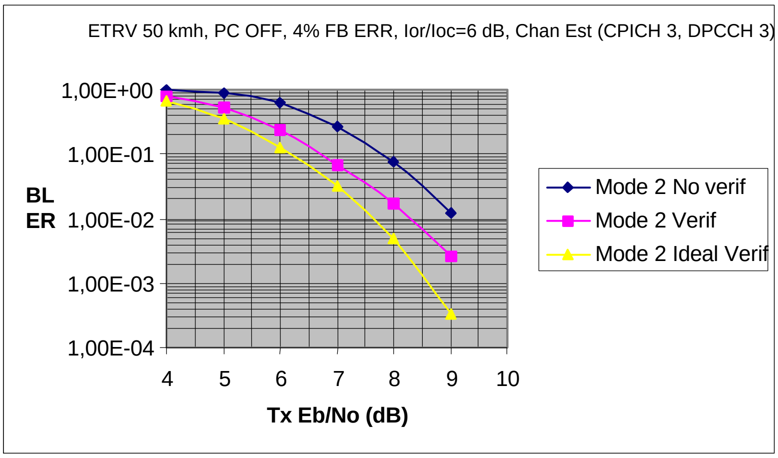


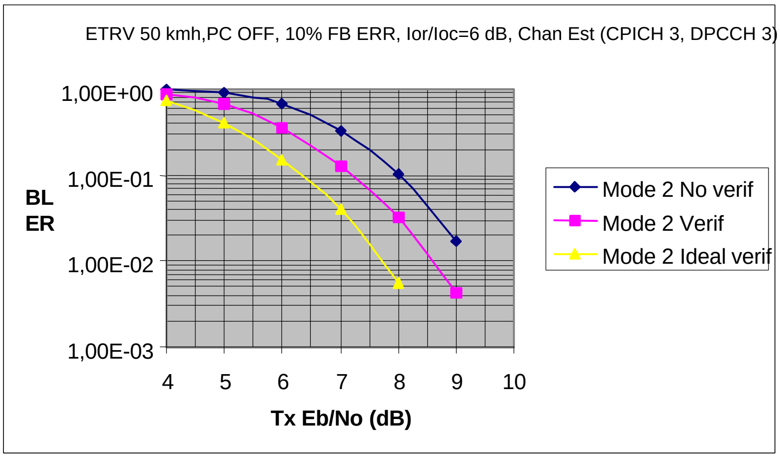




3.3 Performance for ETRV A 50 km/h







4 Conclusions

- A generic algorithm for verification for transmission diversity mode 2 has been defined and has been validated through simulations.: At a BLER of 10^{-2} and for a nominal feedback error rate of 4%, verification for mode 2 gives a gain of 0.7dB for all mobile speeds up to 50km/h.

- The verification algorithm described does not require any changes to the current RAN1 specification. Therefore, the algorithm could be implemented within a release 99 UE.

- For release 2000, the verification algorithm for mode2 could be described in 25.214 annex A(informative) that already contains the verification algorithm for mode1.

- The performance benefits of applying verification for transmit diversity mode 1 and 2 should be considered by RAN4 in setting minimum performance requirements for release 2000.

5 References

[1] R1-99c86, *Modified closed loop modes for WCDMA*, TI, Aug 24th, TSG-RAN WG1 meeting #7, Aug 30th-Sep 3rd, Hanover, Germany

[2] 3G TS 25.214 v3.2.0, TSG RAN, Physical layer procedures (FDD), 2000-03.