Agenda item:

Source: **MOTOROLA**

Title: Progressive Refined Tx AA Modes

Document for: Discussion and approval

Summary:

In order to keep the currently defined closed loop Tx diversity solution and to improve the performance a slight modification to the existing concept is proposed. By accepting the basic proposal we get the following benefits:

- Constant Update rate of 1500 Hz gives improved performance
- UE knows what coefficients the UTRAN applies on each slot => improved performance, allows Verification
- Minimal Changes in the Specifications

Note that all the claimed benefits of the refined modes proposed by Nokia are also acheived with relatively much less changes to the current defined modes.

Moreover, there is no phase ambiguity and difficulty in SHO situation.

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1. INTRODUCTION

In the TSG-R WG1 meeting #5 the Tx diversity closed loop modes were unified in that they all are based on Tx AA concept [1]. In order to increase the update rate of the current defined modes and therefore offer improved performance, the following minor changes are proposed.

It should be noted that, these changes offer both as good or better resolution than the proposed refined modes from Nokia. Furthermore, in terms of reducing the feedback delay, the results show significant improvements over the proposed refined modes. Finally, these improvements are obtained with a relatively minimal change in the current specifications.

As a by-product, these results have an impact on higher speeds limits up to which the closed loop Tx-AA modes can be used.

2. PROGRESSIVE REFINED TX AA MODES

In the current Tx AA modes, as defined in Table 1, some of the current feedback modes which provide larger resolution in terms of phase constellation on the diversity antenna suffer from signalling delay, because of the update rate of the TX AA coefficients at the Node B. As an example, for the current mode 3, a 4-bit word is used to adjust both phase and amplitude with an update rate of 400 Hz. Thus the Node B waits for 4 slots (2slots) for the case of 1 feedback bit per slot (2 feedback bits per slot) in order to reconstruct the TX AA word to be applied. Therefore, this mode can only be applied in very slow time varying channel conditions.

One solution as proposed by Nokia is to filter the feedback commands or the associated weights in order to optimise the performance for the given link/cell. Basically, on the UE side, it chooses from the diversity antenna constellation, which has only two points, which are rotated by 90 degrees (R-2) or 45 degrees (R-4) every slot. Then the Node B filters over 2 slots (R-2) or 4 slots (R-4).

We propose a progressive refinement of the TX AA words which enables both the UE and the Node B to update their TX AA word every slot. Therefore, this results in a higher update rate and performance improvement while keeping the high resolution of the constellations and allowing averaging of the DPCCH at the UE.

This is realised without any averaging at the Node B as opposed to the proposed refined modes by Nokia. Therefore, the Node B applies the coefficients which are requested by the UE resulting in performance benefits and the possible application of verification techniques.

2.1 Existing closed loop solution

Table 1 list some parameters describing the current Tx AA modes. Note that actually modes 4 and 5 are the same as 3 and 4 except that there are 2 Feedback Bits per slot for modes 4 and 5.

FB mode	N_{FBI}	N_W	Update rate	Feedback bit rate	N_{po}	N_{ph}
1	1	1	1600 Hz	1600 bps	0	1
2	1	2	800 Hz	1600 bps	0	2
3	1	4	400 Hz	1600 bps	1	3

4	2	1	1600 Hz	3200 bps	0	2
5	2	2	800 Hz	3200 bps	1	3

Table 1. N_{FBI}, N_W, *update rate, feedback bit rate and number of power and phase bits per signaling word for different feedback modes. Chip rate of 4.096 Mchip/s is assumed.*

2.2 Progressive Refined closed loop solution

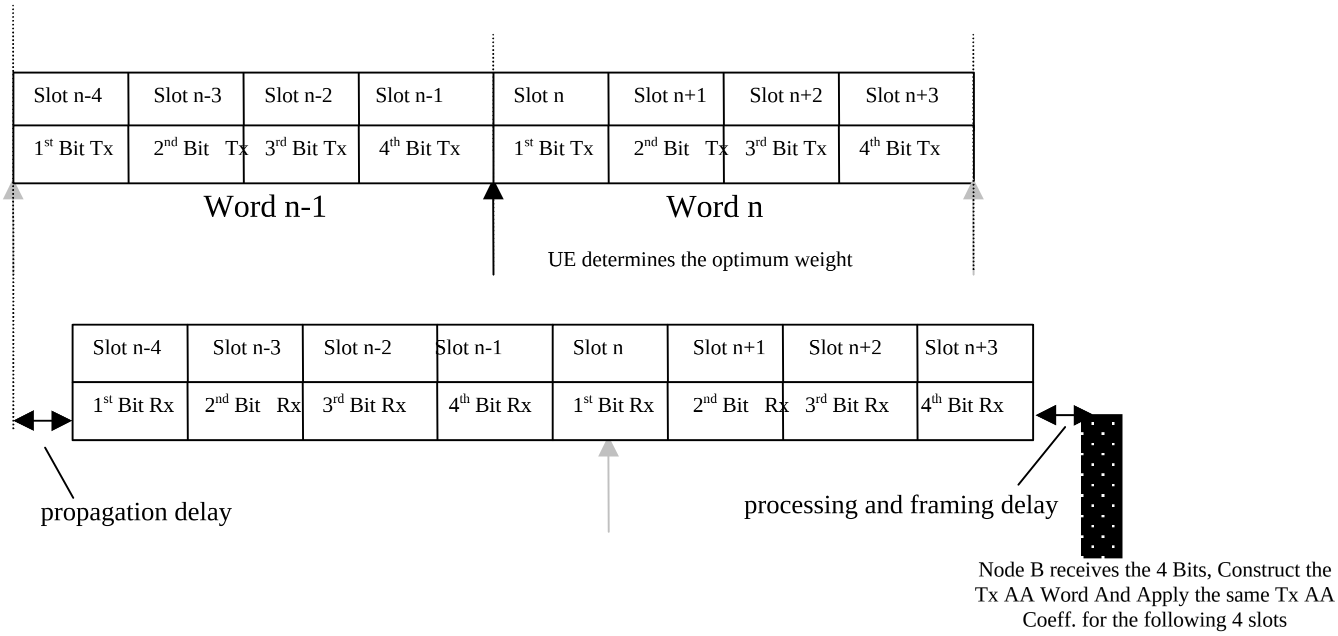
In the following the current mode 3 is taken as an example. However, without the loss of generality, the designed scheme holds for any mode with number of bits per word higher than the number of feedback bits.

Consider the current feedback mode 3 which is defined as follows :

Tx AA Mode	3
Phase bits Gain bits Feedback delay (slots)	3 1 4

Table 2 Feedback Parameters

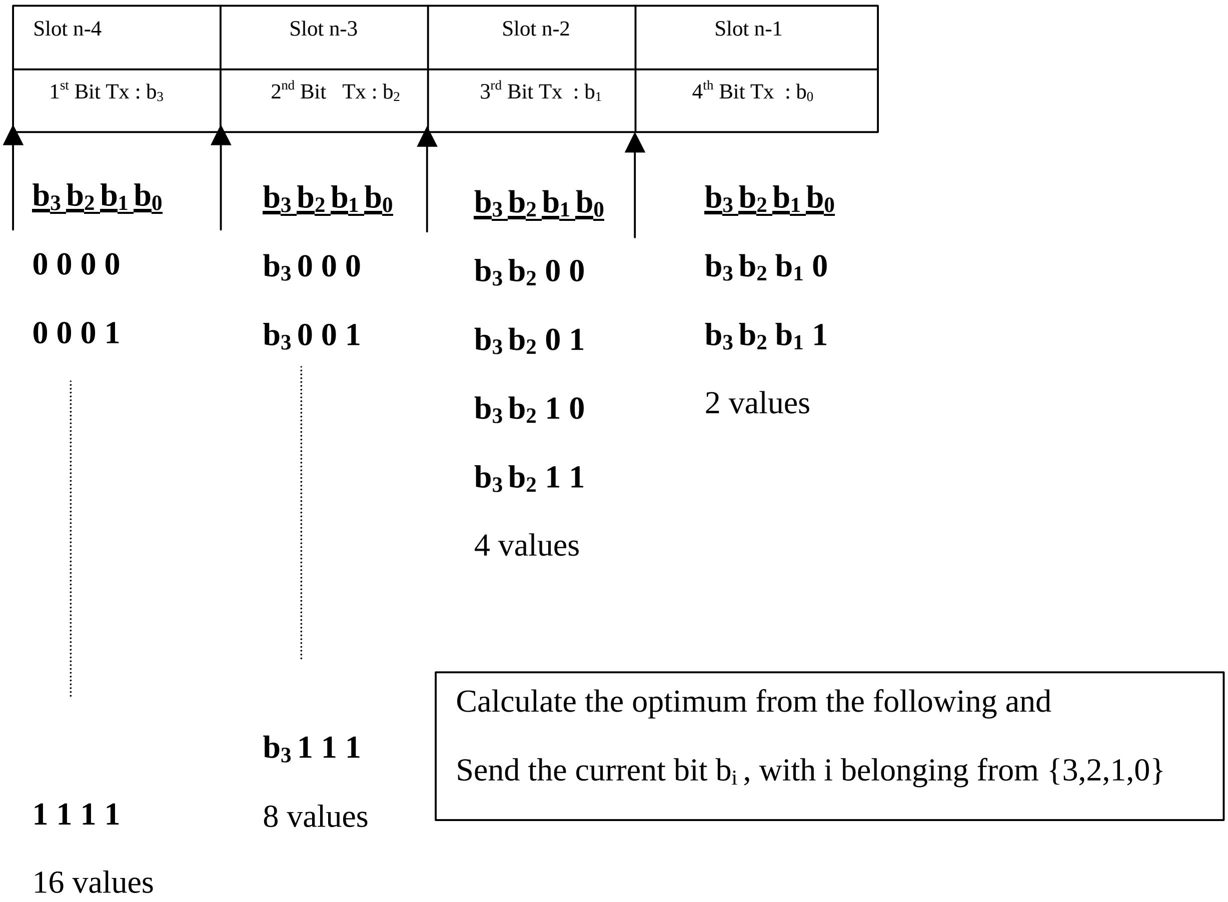
The current mode 3 is designed as shown in the following diagram.



Progressive refinement at the UE.

The first modification is that instead of waiting four slots to calculate the next optimum weight, the UE determines the optimum weight, from the set of Weights allowed given the previously transmitted bits of the feedback message, that should be applied at the UTRAN access point to maximize the UE received power.

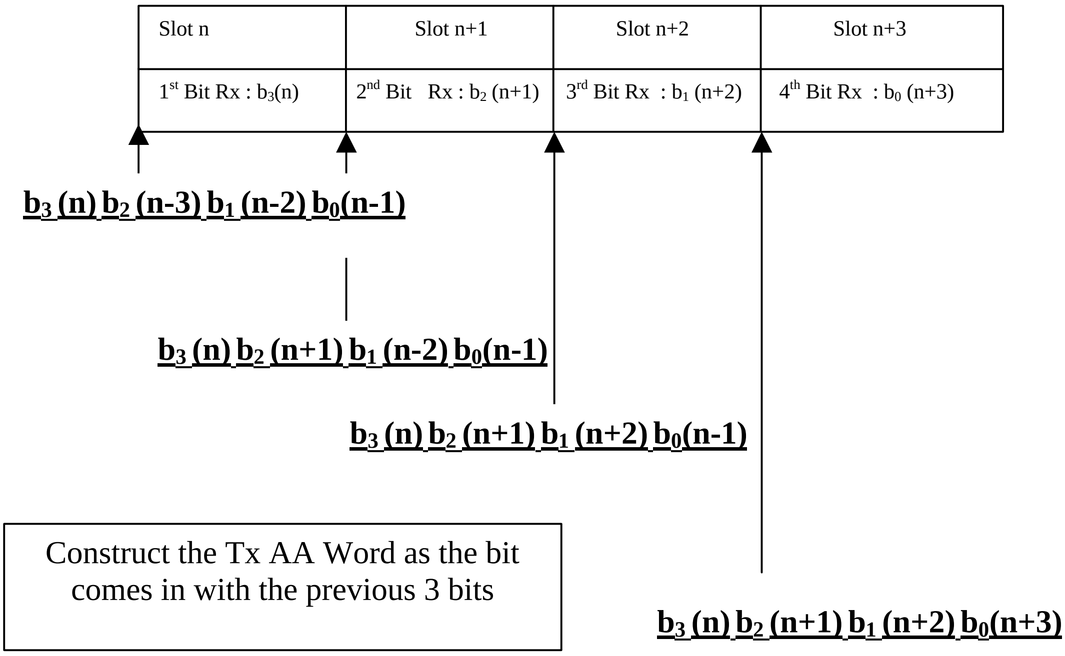
This is described in the following diagram.



<u>Progressive refinement at the Node B.</u>

In this case the modification is that instead of waiting for the four slots corresponding to construct a the Tx AA word, every slot time the Node B constructs the Tx AA message (word) from the most recently received bits for each position in the word.

This modification is illustrated in the following diagram.



It is clearly seen from the progressive refinement at the UE that if the channel changes from one slot to another the UE can determine the new optimum coefficients for the current slot, thereby refining the Tx AA word sent.

In parallel, at the Node B side, it is clearly seen that the BS can apply the Tx AA coefficients every slot by progressively constructing them.

It should be noted also that in these refined schemes, the Node B applies the coefficients the UE requested.

2.3 Simulation results

The simulations are for the 8 kbps speech service for the downlink WCDMA UMTS. The link level simulations parameters are given in the following table :

Chip Rate	4.096 Mcps
Data Rate	8 kbps Speech Service
Modulation	QPSK
Physical Channel Rate	32 ksps
Interleaving	10 ms
Convolutional Coding Rate	1/3
Pilot/TPC/TFI	8/2/0
Ior/Ioc	6 dB
PCCPCH Power	10% of Ior (Total BS Power)
PC/Tx AA feedback rate	1.6 kb/s
PC feedback errors	1%
Tx AA feedback errors	4%
PC delay	1 slot (0.625 ms)
Tx AA delay	1 slot
PC Step	1 dB

Table 1 : Simulation Parameters

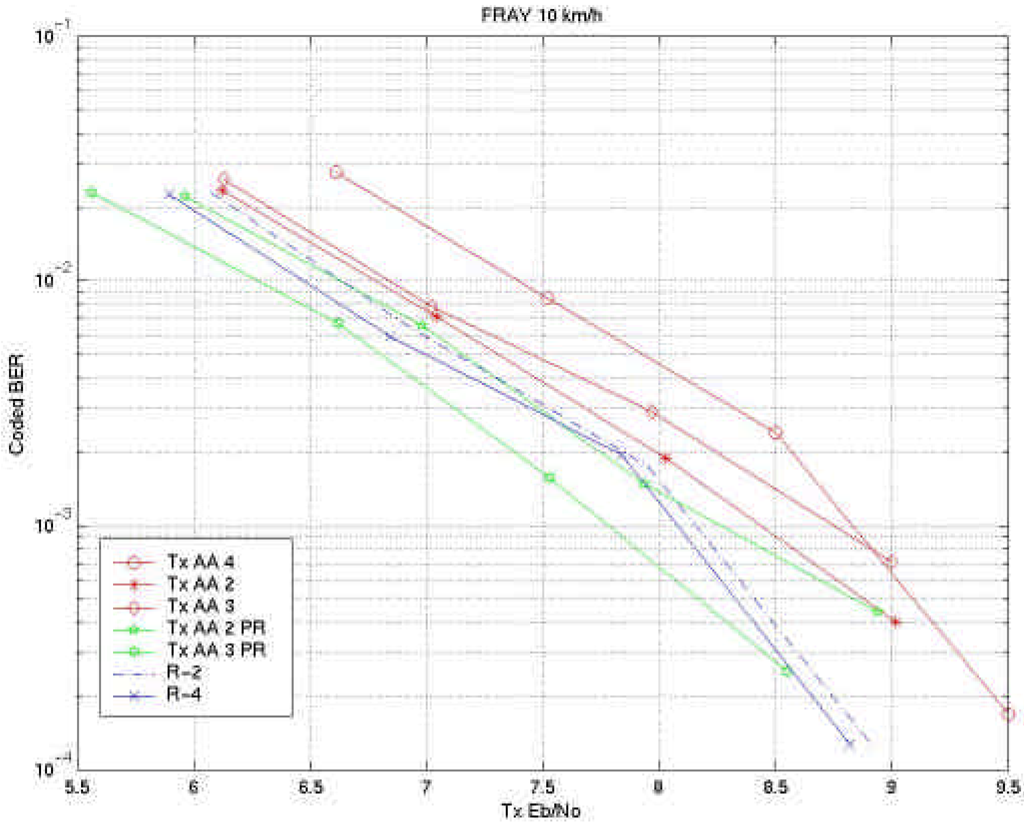
The number of slots (averaging) used for the channel estimation on the pilots from the PCCPCH (for the weight calculation) and from the DPCCH (for RAKE receiver) are indicated at the top of the graphs. Three-slot-zero-phase weighted average on DPCCH utilises filter coefficients [0.4 1 0.4]/1.8.

BER	Bit Error Rate
PCCPCH	Common Control Physical Channel
DPCCH	Dedicated Physical Control Channel
FRAY	Flat Rayleigh Channel
ETRP	ITU Pedestrian A Channel
ETRV	ITU Vehicular A Channel

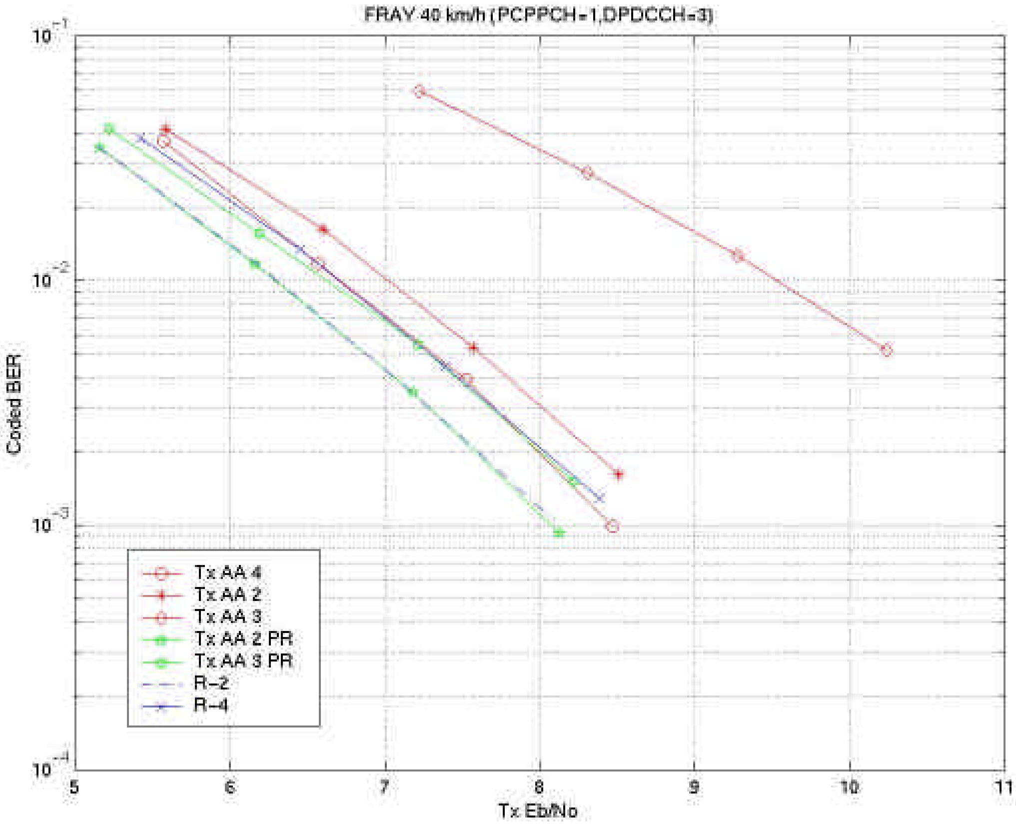
Table 2 : List of Abbreviations

Simulations has been done for different types of channels at relatively low and high speeds.

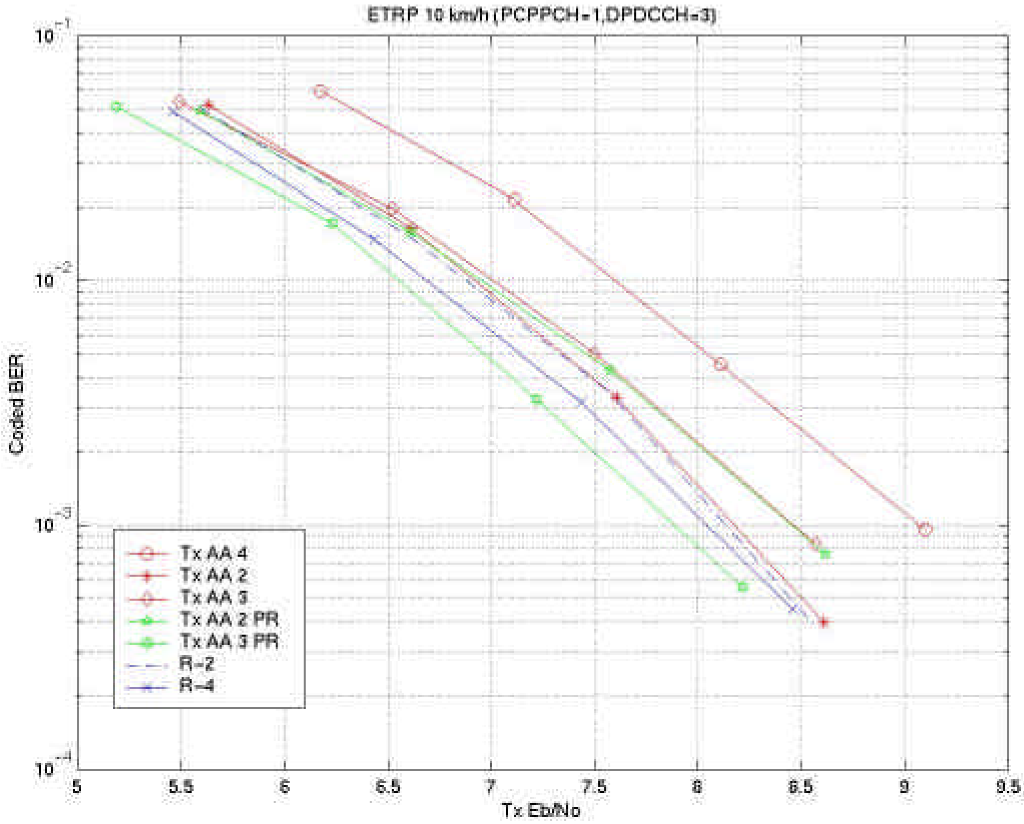
2.3.1 FRAY 10 km/h



2.3.2 FRAY 40 km/h



2.3.3 ETRP 10 km/h



From the above results it is clearly seen that the progressive refine modes (PR) at the UE (MS)and Node B (BS) ameliorate quite significantly the current Modes as defined in the 3GPP Specifications both at low and high speeds. More importantly, they outperform the refined modes as proposed by Nokia.

3. CONCLUSIONS

Some of the current feedback modes which provide larger resolution in terms of phase constellation on the diversity antenna suffer from signalling delay, because of the update rate of the TX AA coefficients at the Node B.

In order to mitigate these effects, minor modifications of the current Tx AA modes suffering from feedback delay more than 1 slot are proposed. The proposed progressive refinement of the TX AA words enables both the UE and the Node B to update their TX AA word every slot. Therefore, this results in a higher update rate and performance improvement while keeping the high resolution of the constellations and allowing averaging of the DPCCH at the UE.

This is realised without any averaging at the Node B as opposed to the proposed refined modes by Nokia. Furthermore, the Node B applies the coefficients the UE requested, thus enabling the use of the optional verification method.

REFERENCES

[1] Ad Hoc #6. Ad Hoc #6 report to RAN WG1 meeting #5. TSG-R WG1 document, TSGR1#5(99)563, 1-4th, June, 1999, Cheju, Korea, 6 pp.