TSG-RAN Working Group 1 Meeting No. 6
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TSGR1-917/99

Agenda Item: **Ad Hoc 1**

Source: **Bosch**

Title: **Battery Savings using Joint Predistortion**

Document for: **Discussion**

Introduction

The purpose of joint predistortion (JP) is to reduce UE base band complexity in the TDD mode. A first estimate of complexity savings has been presented in [1]. Here we present updated estimates, which now take into account variable spreading and channel estimation. Furthermore, rough estimates of battery savings by using JP instead of joint detection (JD) will be given.

Complexities

Fig.1 and 2 compare the detection complexities when using JP or JD. For the analysis, burst type 1 and no receive antenna diversity have been assumed. Spreading factor two has been used in slots which are fully loaded by a single user. Channel estimation has been assumed to be performed by FFT operation as proposed in [2].

The numbers of required real multiplications are shown for the one finger Rake detector (in the case of JP), the approximate MMSE and the low cost joint detector proposed in [3]. Fig.1 shows the results for the indoor A environment. Fig.2 assumes the vehicular A environment. The complexities of approximate joint detection are taken from [4].

The figures clearly show that JP greatly reduces detection complexity by a factor of 4 to 20 compared to JD. The complexity is most distinctly reduced at high data rates.

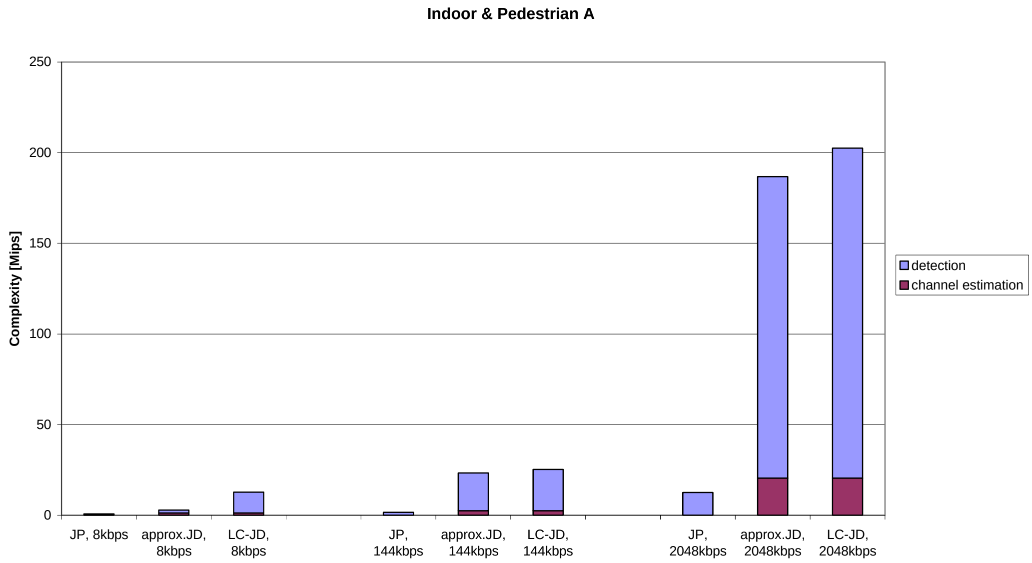

Fig.1: Mips requirements (real multiplications) of JP and JD in the indoor and pedestrian A environment.

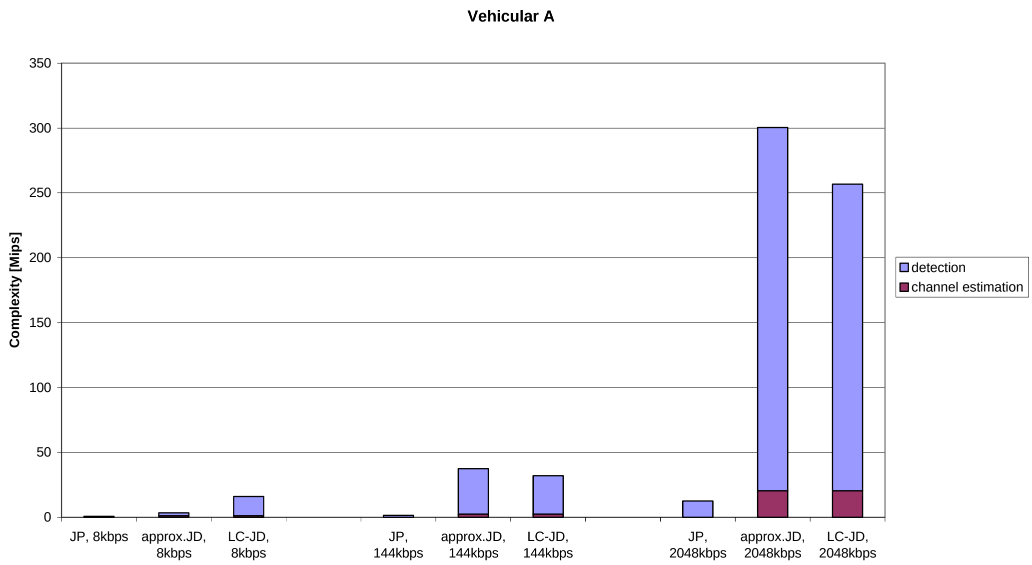

Fig.1: Mips requirements (real multiplications) of JP and JD in the vehicular A environment.

Battery Savings

The complexity reduction by JP results in battery savings. In order to determine relative battery savings, the power consumptions of all terminal components must be taken into account. Since power consumption depends on the actual implementation, it must be clear that only rough estimates can be given here. Nevertheless the estimates can point out tendencies.

For the following analysis we assume a basic terminal without any application implemented. The receiving part consists of RF, channel estimation, detection and channel decoding.

Tab.1 and 2 list power consumption estimates of the baseband components. According to [5] channel estimation and detection consumptions have been calculated under the assumption of 3mW per Mips (real multiplications). For channel decoding a consumption of 50mW per Mbps has been assumed. This value has been extrapolated from the power consumption of a hardware implemented Viterbi decoder actually used by an available DAB chip.

	JP	Approximate JD	Low cost-JD
Channel estimation	-	3.84 / 7.68 / 61.38	3.84 / 7.68 / 61.38
Detection	2.34 / 4.68 / 37.47	4.5 / 62.4 / 499.2	34.14 / 68.28 / 546.3
Channel decoding	0.4 / 7.2 / 102.4	0.4 / 7.2 / 102.4	0.4 / 7.2 / 102.4
Overall baseband	2.74 / 11.88 / 139.87	8.74 / 77.28 / 662.98	38.38 / 83.16 / 710.08

Tab.1: baseband power consumptions in mW at data rates 8kbps / 144kbps / 2048kbps for the indoor environment.

	JP	Approximate JD	Low cost-JD
Channel estimation	-	3.84 / 7.68 / 61.38	3.84 / 7.68 / 61.38
Detection	2.34 / 4.68 / 37.47	6.3 / 105 / 840	44.31 / 88.65 / 709.2
Channel decoding	0.4 / 7.2 / 102.4	0.4 / 7.2 / 102.4	0.4 / 7.2 / 102.4
Overall baseband	2.74 / 11.88 / 139.87	10.54 / 119.88 / 1003.78	48.55 / 103.53 / 872.98

Tab.2: baseband power consumptions in mW at data rates 8kbps / 144kbps / 2048kbps for the vehicular environment.

Overall power consumptions are shown in fig.3 and 4. According to [5] RF has been assumed to consume 163mW in small cells and 350mW in large cells. The battery savings are most distinct at high data rates. About 20% and 60% power will be saved at 144kbps and 2048kbps respectively.

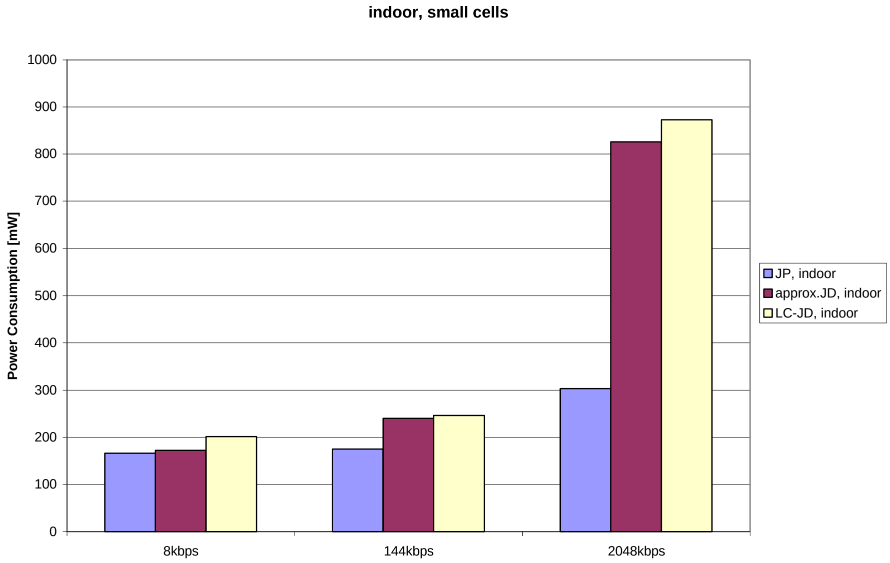

Fig.3: overall power consumptions in the indoor environment in small cells.

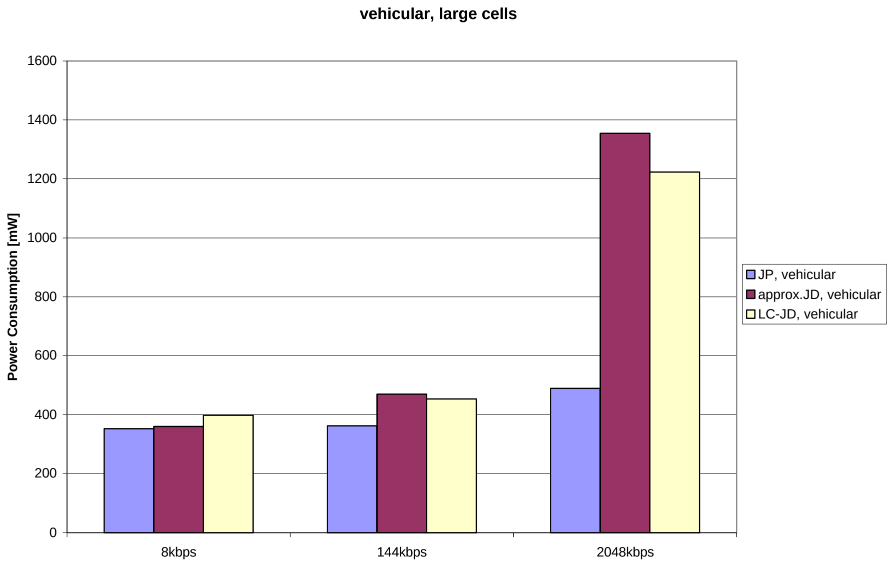

Fig.3: overall power consumptions in the vehicular environment in large cells.

Conclusions

Although the presented analysis can only roughly estimate UE power consumptions, the results clearly indicate a considerable amount of battery savings by using JP instead of JD. Most power will be saved at high data rates. The results show that battery life time may be extended by 25% and 150% at 144kbps and 2048kbps respectively.

References

[1] Tdoc SMG2 UMTS-L1 553/98, “Joint Predistortion Detection Complexity”, source: Bosch, Nov. 1998.

[2] Steiner, Jung: “Uplink channel estimation in synchronous CDMA systems with Joint Detection”, PIMRC’93, Yokohama.

[3] Tdoc SMG2 UMTS-L1 362/98, “Low Cost MMSE-BLE-SD Algorithm for UTRA TDD Mode Downlink”, source: PA / Racal, Sept. 1998.

[4] Tdoc SMG2 UMTS-L1 301/98, “Receiver complexity with variable spreading option (TDD part)”, source: Alcatel, Sept. 1998.

[5] Tdoc SMG2 270/97, “Concept Group Alpha – Wideband Direct-Sequence CDMA, Evaluation Document (Draft 1.0), Part 2”, source: SMG2 Wideband DS-CDMA concept group (Alpha), Oct. 1997.