Input paper: [1] ENAV23-3.1.12

Input paper for the following Committee(s): check as appropriate

□ ARM □ ENG □ PAP

☒ ENAV □ VTS

Purpose of paper:

☒ Input

□ Information

Agenda item [2] (from agenda)	3.1
Workplan Task Number / Technical Domain [2]	……
Working Group	WG 3
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On the Efficiency of VDE ARQ

1 SUMMARY

The present document describes an improved data packet retransmission (ARQ) mechanism over the one in the current VDE by exploiting the turbo coding structure. The simulation result shows significant performance improvement both in AWGN and fading channels, which translates to either SNR reduction under the same transmission resources or the same SNR with reduced transmission resources.

1.1 Purpose of the document

This input document addresses the efficiency issue of VDE ARQ, and proposes an improved ARQ scheme.

1.2 Related documents

[1] Hans-Christian Haugli, IALA G1139 proposed changes to VDE-SAT by Norway, Oct. 9, 2018.

2 DISCUSSION

During wireless transmissions, it is very common that some packets are received with decoding errors as a result of a mismatch between the Link ID used in the transmission and the channel (due to, e.g., inaccuracy in channel prediction), in which a retransmission, i.e., ARQ, is typically needed.

In the current VDE (VDE-SAT and TER) ARQ, the transmitter simply repeats exactly the same transmission (not allowed to change). Moreover, the receiver discards the previous transmission and tries to decode the packet independently, i.e., without using the previously received data. Figure 1 [(a) and (b)] illustrates this scenario.

The problem lies in the fact that the existing VDE retransmission does not combine ARQ with forward error correction (FEC) coding – neither the VDE transmitter nor the VDE receiver takes advantage of the previous transmissions:

(1) At the receiver, the VDE decoder uses the current retransmission alone for decoding. Under an AWGN or slow fading channel (typical for the VDE-SAT channel with 0.02Hz fading cycle [1]), the channels are highly correlated between two consecutive transmissions. Hence using all the transmissions for decoding can clearly boost the receive data SNR or lower the code rate, and

1 Input document number, to be assigned by the Committee Secretary

2 Input papers should be assigned to a work task as listed in the Committee work plan which is available in input papers. Leave open if uncertain but consider how the paper is to be processed if not relevant to a work task

hence higher decoding success probability than using the retransmission data alone. Under a fast fading channel, *statistically* the decoder will still benefit from the previous transmissions as demonstrated by the following simulation results.

(2) At the transmitter, the systematic structure of the turbo code is not fully exploited by VDE. Typically (especially for low code rate and slow fading), retransmissions using different set of code bits that are generated for the same information bits by the turbo encoder achieve better decoding performance.

We therefore propose to use the improved ARQ scheme as illustrated in Figure 1 (c) and (d). In (c), the transmitter retransmits the same data as the 1st transmission and the receiver combines both transmissions to boost SNR. In (d) the transmitter transmits the different set of code bits from the 1st transmission and the receiver use both transmissions to reduce the code rate. The improvements over the existing VDE ARQ is demonstrated in the following section.

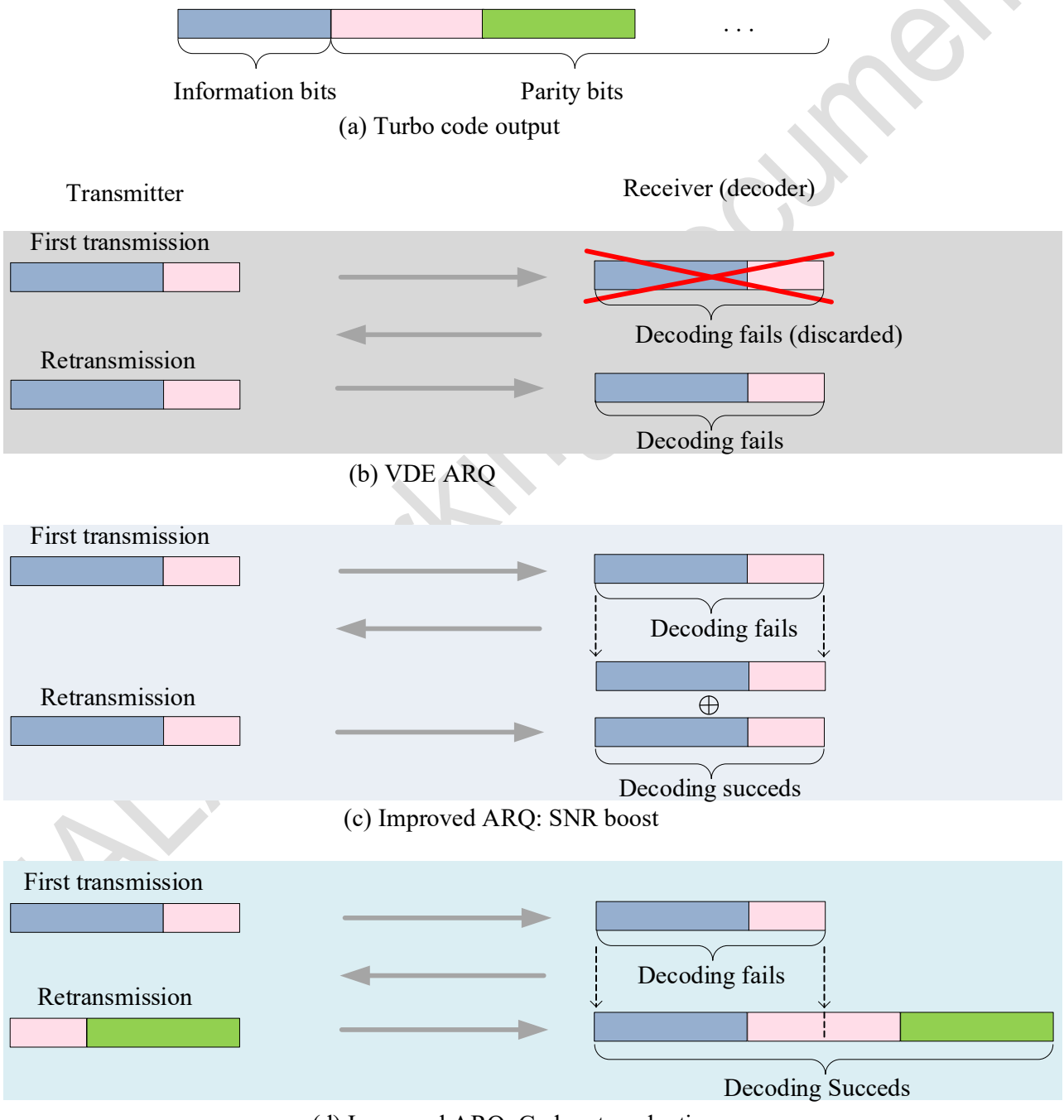
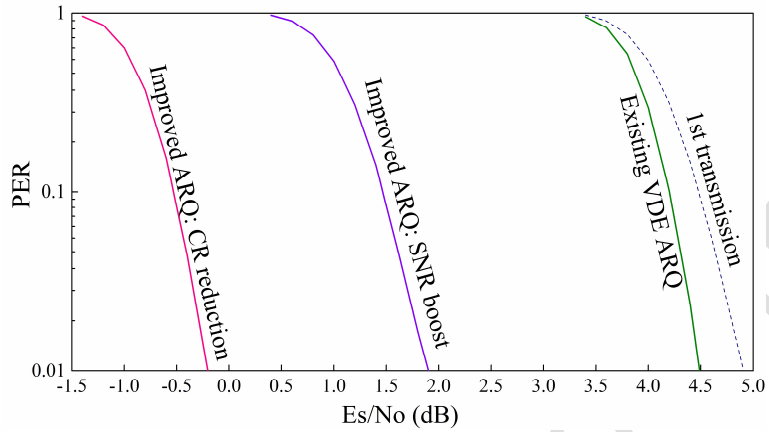


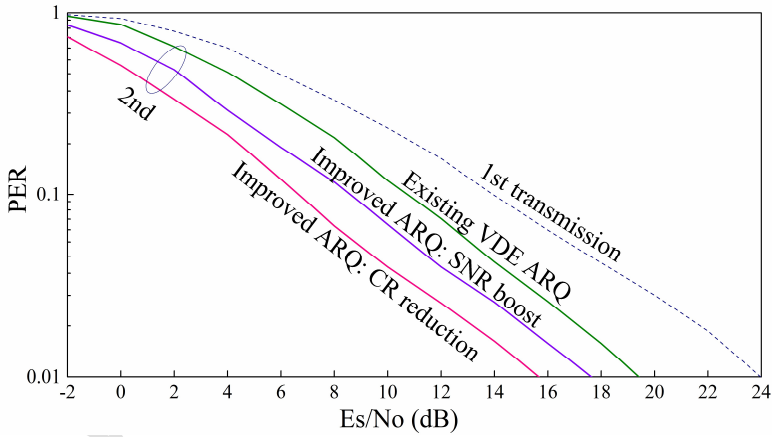
Figure 1 Simplified illustration of ARQ schemes.

3 SIMULATION RESULTS

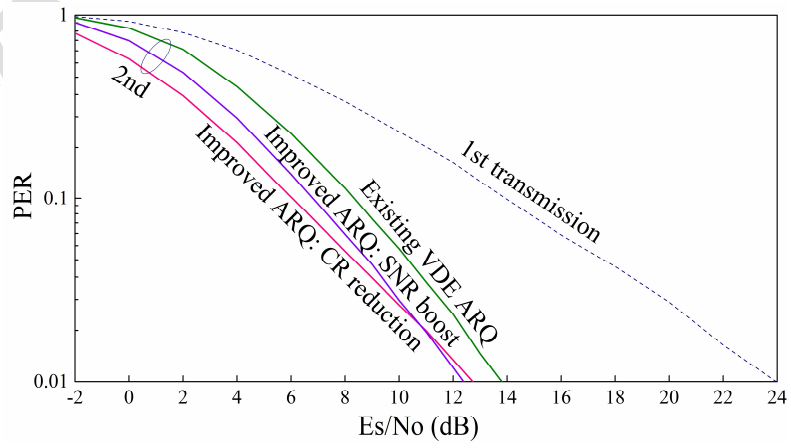
In the simulations, the VDE turbo encoder generates a sequence of code bits as shown in Figure 1 (a). We compare the ARQ performance between the existing VDE ARQ with the two improved schemes with SNR boost and code rate reduction. From Figure 2 and Figure 3, it is clearly observed that both improved ARQ schemes show gains over the VDE ARQ. However, the code reduction scheme outperforms the "SNR boost" scheme at higher code rate and slow fading where "code rate (CR) reduction" is more effective than "SNR boost" on decoding performance. The gain over VDE is more than 3 dB in slow fading and close to 2 dB in fast fading.



(a) AWGN channel

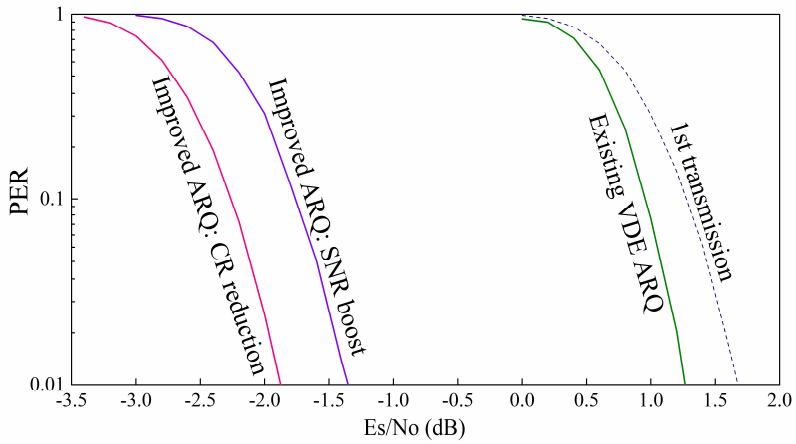


(b) Rayleigh fading channel (mobile speed 3km/h or 0.5 Hz)

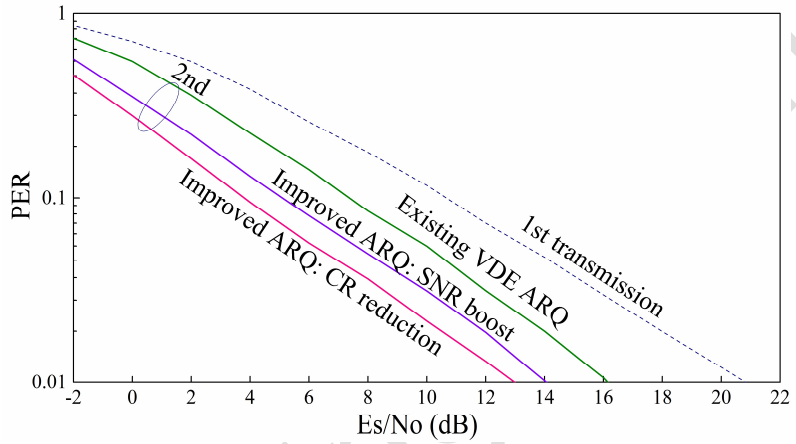


(c) Rayleigh fading (mobile speed 60km/h or 10 Hz)

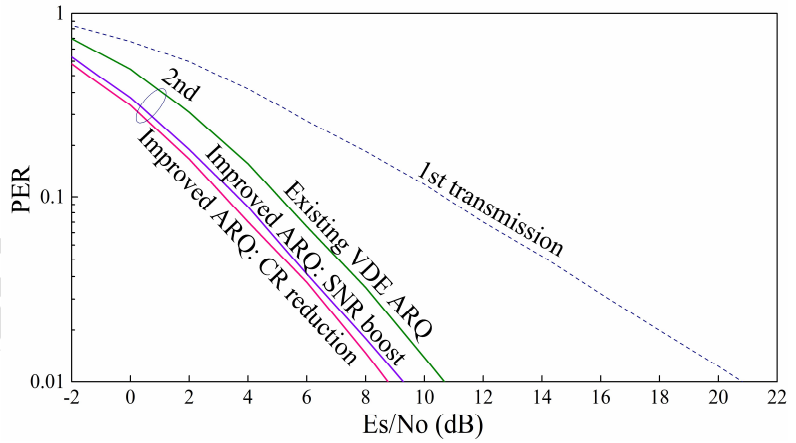
Figure 2 ARQ performance comparison under different channels, where the code rate of the first transmission is 3/4.



(a) AWGN channel



(b) Rayleigh fading channel (mobile speed 3km/h)



(c) Rayleigh fading (mobile speed 60km/h)

Figure 3 ARQ performance comparison under different channels, where the code rate of the first transmission is 1/2.

4 ACTION REQUESTED OF THE COMMITTEE

Discuss and adopt the improved ARQ scheme, i.e., the code rate reduction scheme (specifications are provided in a separate input).