

Agenda Item: 8

Source: Lucent Technologies

Title: Recommendations concerning the selection of turbo coding scheme

Document for: Discussion

With this document Lucent does not intend to question the fairness of the chairman and participants of the Adhoc 5 working group, whose behaviour was at all co-operative and open. The document's only scope is to share with the participants in the plenary session some concerns that Lucent has about the time devoted to the analysis of all aspects involved in this important decision to be made.

The Adhoc 5 meeting held in Monday evening was attended by only a few companies, and within them, even fewer were actively involved in the discussion for selecting the coding scheme and the code-embedded interleaver. Actually, only those companies having some proposals related to the decision to be made were participating to the discussion. The report for the plenary meeting has been made on the basis of a majority within the small group of active participants. As minority, and due to late hour, we did not want to further insist in discussions.

In this document, we outline some important points, in order to make all companies attending the plenary session fully aware of the framework in which the report has been prepared.

1. Two candidate codes chosen from ETSI and one from ARIB were considered in TSGR1#2(99)050 for a final decision of the Adhoc 5 working group, and two criteria for the selection were established, i.e., **performance** and **complexity**. The output of Adhoc 5 is the following:
 - The 8-state PCCC scheme is recommended for services which require a BER= 10^{-3} - 10^{-6} .
 - The 4-state SCCC scheme should be considered for further study for services which require a BER $<10^{-6}$.
2. Lucent thinks that the decision had been based only on the E_b/N_0 gain of PCCC ranging from 0.1 to 0.35 dBs in the BER range 10^{-3} - 10^{-6} .

There were several issues not considered with the necessary attention in the selection process:

- The **implementation complexity** of the two competing schemes. Based on a detailed analysis of the ASIC implementation complexity, we showed that 8-state PCCC suffers from an increase from 16% to 79% in implementation complexity with respect to the 4-state SCCC, depending on the information block size (see TSGR1#2(99)110). In Adhoc 5 meeting, there was not enough time to discuss in depth this subject.
- The **minimum Hamming distance**, a crucial parameter for any code. In TSGR1#2(99)036 we showed that 4-state SCCC, for all block sizes, yields a considerably larger minimum distance than 8-state PCCC.
- The **code versatility for different data rates and QoS** (e.g., those requiring BER lower than 10^{-6}). Based on an analysis of its behaviour for low data rates (see TSGR1#2(99)110), and on the fact that it

does not show error floors in BER and FER curves, SCCC seems to be a very strong candidate for all data rates and QoS. Adhoc 5 group has only left a space for it in those QoS requiring $BER < 10^{-6}$.

- **Patent issues.** SCCC is free from patents, having being published in the open literature, whereas several patents cover the PCCC scheme.

In TSGR1#2(99)89 we included in tabular form a comparison between the codes covering all the important features. That document too, which Lucent recommends to consider for making a decision, has not been discussed in the Adhoc 5 meeting.

In conclusion, we think that the only advantage of the 8-state PCCC is 0.1 – 0.35 dB in the BER range of 10^{-3} - 10^{-6} . This difference in performance is so small, that the two codes can be considered almost equivalent in this aspect, so that the other aspects should be carefully taken into account for a final decision.

We admit that the proposal of 4-state SCCC has been raised late to the attention of ETSI, at a time when the PCCC schemes had been considered and discussed for several months. For this reason, a careful, comparative analysis has not been possible for most of the interested companies. In the last months, however, Lucent has generated 14 documents covering all aspects, from the basic coding-theoretical behaviour to in-depth simulations and detailed ASIC and DSP implementation, of the two coding schemes in order to catch up with the initial delay.

Recommendation

In view of the above considerations and concerns, and on the fact that Adhoc 5 working group did not make a decision for the code-embedded interleaver among the candidate solutions (MIL, GF, AL-N, AL-C), which means actually that the overall code is still to be selected, being the interleaver a major part of the code, we recommend to postpone the final decision concerning the choice between PCCC and SCCC to the next meeting, in which the supporters of the two codes should propose a complete solution, including the optimized interleavers allowing the final, overall choice.

We will add, to the set of contributions already available, a careful analysis of the error floor behaviour regarding the suitability for QoS requiring $BER < 10^{-6}$, and results on lower data rates below 32 kbit/s.

In view of the final decision, we are prepared to make our document available on the reflector one week before the next meeting, and, if considered important for the final decision, to make a presentation to the plenary session in the next meeting.