Channel Utilization Enhancement and Energy Optimization in Mobile Communication through Efficient Data Interleaving Technique

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Abstract-Increasing number of mobile subscribers along with plethora of bandwidth intensive applications has energized the researchers to look at the early instances of capacity exhaustion. As a consequence, the optimum utilization of bandwidth and power consumed by the mobile handset has evolved to be a critical issue for research. The talk time and recharging of mobile handset has been adversely affected due to these bandwidth intensive applications including internet through mobile. Several techniques in voice/speech communication have already been analyzed for channel utilization enhancement but some important issues like freeze out of speech, delay, speech hangover, deterioration of speech and inter-modulation gap problems remained unresolved. In this paper the authors propose an efficient Data Interleaving technique that can be implemented in the field of mobile communication which not only resolve these issues but also can enhance the channel utilization and optimize the energy of battery. This technique has been successfully implemented in voice/speech communication exhibiting channel utilization of the order of 80% as compared to 36% by the other techniques. As this technique is implemented in the field of mobile communication, the battery life and energy utilization of battery of the mobile handset seems to be increased by 30 to 40 %.

Keywords – Data interleaving, Speech Interpolation, Channel utilization, Freeze out.

I. INTRODUCTION

Mobile Communication has emerged out to be the most promising technology of the telecommunication but it has been constrained due to its limited capacity as compared to the wireline networks. The increasing number of mobile subscribers along with the plethora of bandwidth intensive applications has energized the researchers to take initiatives in the direction of channel utilization and energy optimization as they are looking at early instances of capacity exhaustion. Therefore, in light of exploring new service frontiers for mobile communications in the 21st century, still there are many technical limitations of the mobile communication. Everyday millions of new mobile communication users are added to the existing billions of mobile communication users all around the world. One of the main limitations of Mobile Communication is the limited energy storage of mobile handset with available technology. Research is continuously going on to increase energy integration of batteries, decreased demand of energy during idle of handset and developing techniques of unlimited energy storage devices or continuous energy generation without any external source attachment. Based on current trends in mobile broadband usage, a spectrum-demand model developed by Rysavy Research [1] shows that many operators' spectrum could be consumed within three to five years.

Till such development is realized, more focus has been laid on the energy saving when speech communication is 'ON' in mobile communication system. Data Interleaving in voice networks seems to be applicable (with certain modifications and updating) in any existing mobile communication technique to reduce the effective energy requirements of the mobile handset. The result of such a study can be fruitfully translated to design, assemble and optimally operate the actual communication system under consideration.

II. DATA INTERLEAVING TECHNIQUE

A. *Data Interleaving Technique –*

The data interleaving is basically the process of inserting data bytes. The method of data interleaving possesses the following essential attributes:-

- No handover is exhibited.
- Suppression of the transmission of redundant (repetitive) message codes.
- It makes channel space available for additional data transmission.
- There is negligible inbuilt delay in this system and is insignificant for real time applications.
- Unlike speech interpolation processes, it does not make use of any speech detectors.
- The signal delay takes place at the originating node only and is independent of network distance.
- It can detect much smaller duration speech pauses, which are generally more frequent.

The channel space for data interleaving is engendered by repression of repetitious voice byte transmission. Any consecutively repeated codes of voice signals might be considered redundant for transmission as the receiver can replicate the identical code if so directed. For this purpose, the receiver would need one code word of message to be repeated and two code words signifying the start and stop of repetition. Hence data interleaving is possible only if the repetitive code words exceed three in number, as shown in Figure 1.
The data start code and the data stop code serve the dual purpose of informing the receiver about repetition of voice codes as well as about the interleaved data transmission. As the decision about data transmission can only be made when at least four identical voice codes arrive in sequence, it is necessary that the three consecutive voice code words are stored temporarily at the source end before transmission. No further delay is required at the next nodes in cascade. However, the three byte delay in transmission is neither noticeable by the listener nor effects the operation of the system in any adverse way. In fact the delay involved in the interleaving process is so small in comparison to the inherent delay in channel allotment process of speech interpolation systems that the speech quality maintained by interleaved system is far superior then that of systems using speech interpolation.

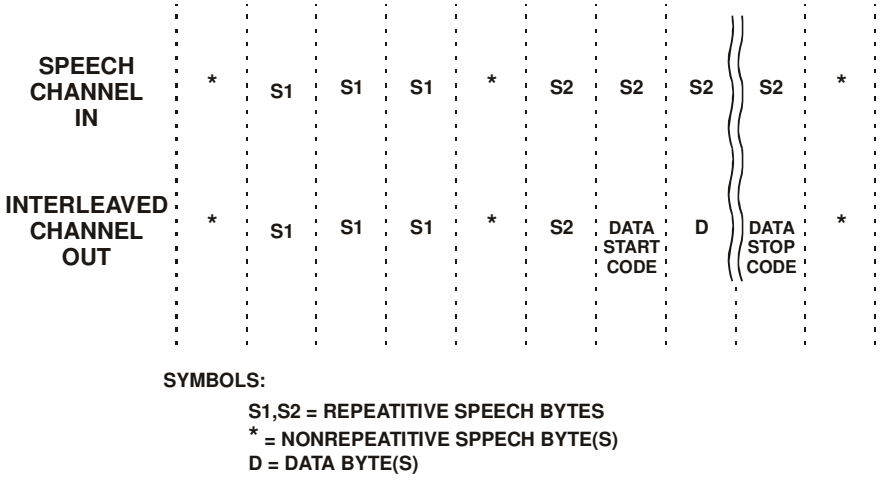

Figure 1. Disposition of Data Interleaving in voice.

The contrivers of Data Interpolation Technique has affirmed a significant improvement of channel utilization of the order of 82% from existing 36% without using any digital interpolation technique. It is also indicated that the technique is applicable in any digital voice network following any standards. The results of the proposed scheme have been confirmed by the contrivers by hardware realization and its testing on an A-law companded standard PCM voice network.

II. EXPERIMENTS AND RESULTS

Nevertheless, it is noted that the studies reported in the final technical report of the data interleaving project was not fully exhaustive and do not reflect in detail the effects of different parameters such as voice pattern on the interleaving process and variety of other factors contributing to improvement in channel utilization. Dr. K. L. Sharma [4] in his study simulated the **Data Interleaving Technique** and obtained various types of results to confirm the suitability and applicability of this technique as under:

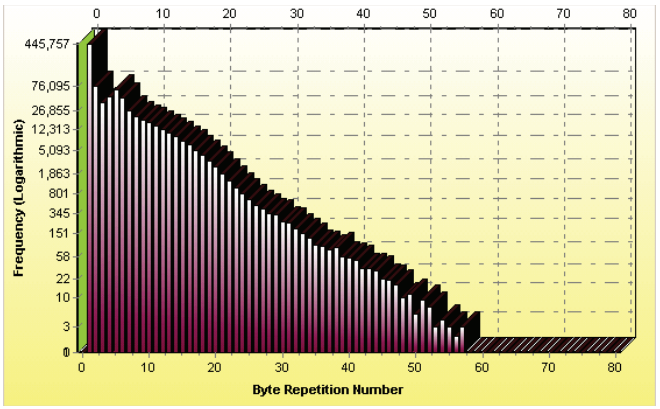

Figure 2. Frequency distribution of Byte Repetition Number of Speech. [4]

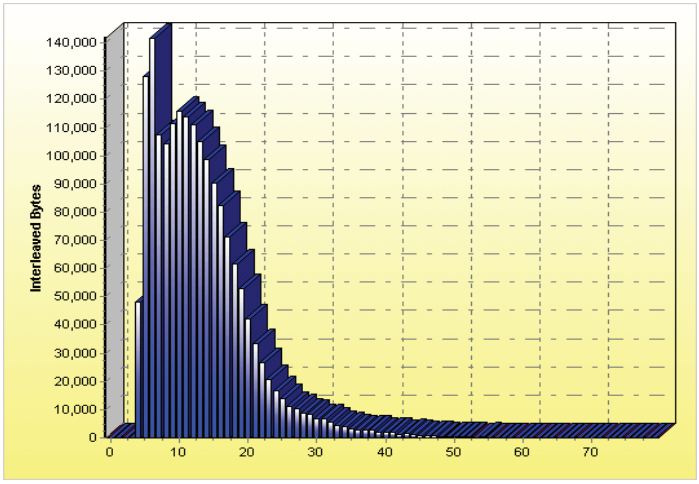

Figure 3. Number of Interleaved data bytes with respect to Byte Repetition Number [4]

The above graph shown in Figure 2 exhibits that the byte repetition normally exists from 2 to 55 (and up to 75 in most cases). As such the interleaved data bytes possibility is shown in graph shown in Figure 3.

The further analysis of channel utilization improvement was obtained as under:

Total number of bytes in the speech sample for 50 samples total bytes (as shown above) = 42384147 Bytes
Total number of bytes, which can be interleaved = 18332415 Bytes
% data interleaved in voice = (18332415/42384147) x 100% = 43.253 %
Channel utilization without interleaving = 36%
Therefore, channel utilization with interleaving = 36 + 43.253 = 79.253 %

The analysis and the derived graphs indicate that the major contribution to the channel utilization improvement is obtainable from byte repetition number 4 to about 75 while some significant contribution continues up-to byte repetition number of about 50, after which the contribution to channel utilization reduces progressively and becomes negligible at byte repetition number of about 75. As the results from various speech samples were quite similar, the computer simulation study demonstrated that the philosophy of interleaving is very well applicable to all types of real voice networks. Further the calculation from the simulation results indicated that the overall channel utilization with data interleaving above becomes of the order of 80% from the original 36% without using any other technique.

III.CONCLUSION

With the implementation of proposed research in mobile communication the channel utilization will definitely be enhanced which will result in the increased energy utilization of the battery of mobile handset by order of 30 to 40%. It means that the mobile handset, which requires charging of battery in 48 to 72 hours, will afterwards need

charging in 72 to 96 hours. Not only the charging of battery, but also the life of battery will increase (as number of recharging of battery is also limited). The 'TALK TIME' of the mobile handset will also increase hence there will be lesser chances of call terminations due to discharge of battery during a call. The size of handset can be reduced as the required energy integration in battery will reduce. This will affect on the cost of the handset also as small battery will then be used.

REFERENCES

[1] Rysavy Research "Mobile Broadband Capacity Constraints And the Need for Optimization" February 24, 2010.

[2] P. S. Tiwari and K. L. Sharma, "Data Interleaving Process in Digital Telephony – A Statistical Analysis"; International Conference on Next Generation Communication Systems: A perspective (ICONGENCOM - 2006), at J. K. Institute of Applied Physics & Technology, University of Allahabad, 9-11 December 2006.

[3] P. S. Tiwari and K. L. Sharma, "Implementation of Data Interleaving in Voice Network"; National Conference on Advances in Electronic Communications (ADELCO) - 2004, at National Engineering College, Kovilpatti (T.N.), 3-4 June 2004.

[4] Sharma K. L., "Study of Data Interleaving in Digital Communication Network and its Application to Network Management System", Thesis for the degree of Ph.D. in Electronics and Communication Engineering, Jai Narain Vyas University, Jodhpur, 2003.

[5] Blanchini F. et al, "Robust Rate Control for Integrated Services Packet Networks", IEEE/ACM Transactions on Networking, Vol. 10, No. 5, pp. 644-651, October 2002.

[6] "Investigation For Efficient Data Interleaving In Voice Network And Development of System Controller" Final technical report of the CSIR research scheme, Department of Electronics and Communication Engineering, Faculty of Engineering, J. N. Vyas University, Jodhpur, 2000.

[7] Gupta N., "Statistical Analysis for Interleaving Data in Digital Voice Networks", Dissertation for the degree of M.E., Department of Electronics and Communication Engineering, Faculty of Engineering, J. N. Vyas University, Jodhpur, 1999.

[8] Rabiner L.R.' "The Impact of Voice Processing on Modern Telecommunications", Speech Communication, 17, pp. 217-226, 1995.

[9] South C.R. et al, "Subjective Performance Assessment of CCITT's 16 kbps Speech Coding Algorithm", Speech Communication, 12, pp. 113-133, 1993.

[10] Horrocks R.J. and Scarr R.W.A., "Future Trends in Telecommunication", John Wiley & Sons, New York, 1993.