Non-monotonicity in Perceived Quality of Delayed Talker Echo ?

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Abstract – The article raises question mark on interpretation of subjective results of talking quality (TQ) and conversational quality (CQ) dependency on echo return loss and echo delay. While the measured dependency has been evaluated as being non-monotonic by at least 2 independent laboratories, clearly showing local minima around 200-300ms, the final parameterization is always monotonic, indicating decreasing perceived quality estimate for increasing echo delay.

Keywords: Conversational Quality, Echo Return Loss, Echo Delay, Perceived Echo Annoyance

1. INTRODUCTION

Talker Echo (TE) is considered as important impairment of contemporary telecommunication networks. Its subjective (perceptual) annoyance can be assessed in repeatable way e.g. acc. to P.800 [1] and the quality parameter directly related to TE is Talking Quality (TQ) [2], and consequently also Conversational Quality (CQ) [2]. Although in the past Listening Quality (LQ) was often considered as a dominant parameter influencing overall telephone conversation quality, TQ and Interaction Quality (IQ) are now taken seriously into account when assessing total call quality.

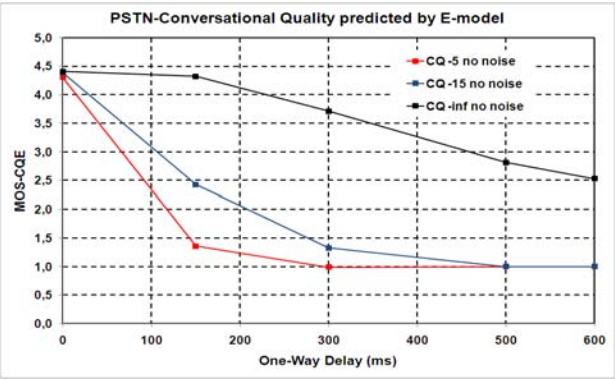

Fig. 1 E-model (G.107) output for 3 different ERL levels (-5dB, -15dB and no echo). Both cases with echo are monotonic.

Even though no objective signal-based model is standardized at the moment, at least parameter-based E-model [3] enables to predict customer opinion on CQ for calls with given TE levels and delays.

Three examples of E-model output (no echo, and echo levels of -5 and -15 dB) are shown in the Fig. 1.

2. SUBJECTIVE TEST RESULTS IN DIFFERENT LABORATORIES

In the past, several subjective tests examining echo perception have been carried by different laboratories for different purposes, e.g. [4] and [5]. The results in case of echoed conversation cases show quite non-monotonic subjective assessment – in the range of cca 200ms one-way delay (corresponding to Echo Delay ED of about 400ms), the subjective perception is quite worse than in the area of 300-400ms of one-way delay (600-800ms echo delay). As both mentioned tests had quite high result variance (not shown in the picture), this non-monotonicity can be easily explained by measurement error caused by low number of tests participants. And – this used to be done sofar.

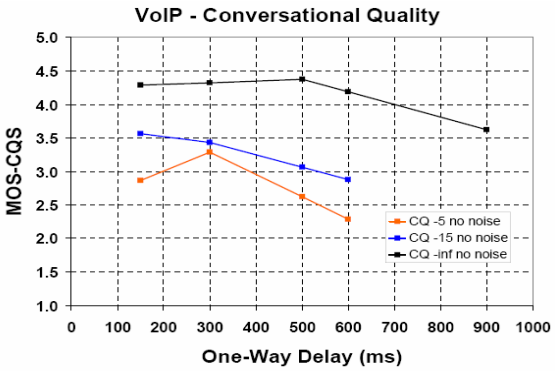

Fig. 2 Subjective test results in Czech experiment. The results for -5dB ERL are non-monotonic. Data for delay of 0 ms are not available, however, it is highly presumable all three curves converge to single value of app. 4.5 MOS.

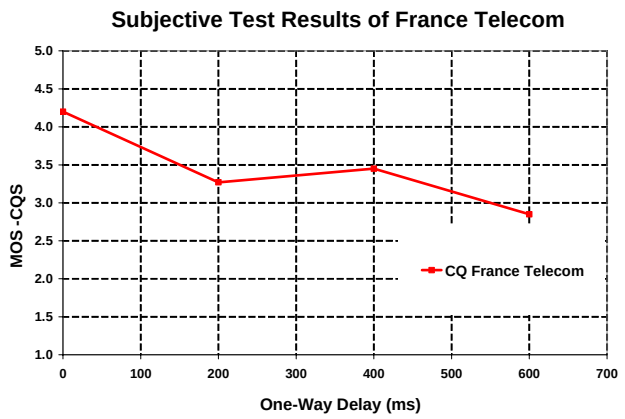

Fig. 3 Subjective test results of France Telecom experiment [4]. The results are again (like ERL -5db in Fig. 2) non-monotonic.

3. ARISING QUESTION

From observation of Fig. 2 and 3, obvious question arises: Is the shown non-monotonicity of CQS versus delay in case of rather strong echo random effect that occurred in both laboratories independently in the same delay position?

More subjective test results should be analyzed to study this topic further. The problem is that raw measurement data are usually not published and only final regression (that does not contain possible original non-monotonicity any more) is available. We assume this is also a way how [3] has been derived.

4. FUTURE WORK

If it is confirmed the above described non-monotonicity is not a random effect, the following aspects should be examined in more details:

- It the position of local CQS minima around 200-300 ms dependent on speaker and its speaking style/speed? Is it true that for faster speakers these minima will be located in shorter delay?
- Is the location of this minima dependent on language and on parameters like average word length?
- Does this effect depend on echo quality, means on distortion of the echoed (and delayed) signal?
- Can be this effect meaningfully deployed in communication industry? It means, is it possible to increase subjective conversational quality by slight INCREASE of transmission delay in case the delay is measured as being located in the "critical area" 200-300ms and it is not possible to decrease it anyhow ?

5. CONCLUSIONS

An original question about non-monotonicity of CQS vs. delay results for highly echoed communications is raised. Its answer requires deeper analysis of already available subjective tests and also carrying new subjective tests focused on this aspect. In case such subjective non-monotonicity is confirmed, it should be reflected properly in future versions of objective models and algorithms.

6. Acknowledgments

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7. References

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