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SERIES J: CABLE NETWORKS AND TRANSMISSION
OF TELEVISION, SOUND PROGRAMME AND OTHER
MULTIMEDIA SIGNALS

Measurement of the quality of service

**Loop latency issues in contribution circuits for
conversational TV programmes**

ITU-T Recommendation J.146

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CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER
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ITU-T Recommendation J.146

Loop latency issues in contribution circuits for conversational TV programmes

Summary

This Recommendation indicates that the loop latency in contribution circuits used for conversational TV programmes can be annoying and can make the resulting programme subjectively unacceptable. The Recommendation presents results of subjective assessment tests on the perceptual impact of loop latency and gives its threshold of acceptability.

Source

ITU-T Recommendation J.146 was prepared by ITU-T Study Group 9 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 July 2002.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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ITU-T Recommendation J.146

Loop latency issues in contribution circuits for conversational TV programmes

1 Scope

This Recommendation provides indications on the value of loop latency preferably not to be exceeded in television programmes that include conversation with persons in distant locations possibly interconnected by means of digital transmission circuit.

2 References

None.

3 Terminology

This Recommendation defines the following terms:

3.1 loop latency: The total transit time of signals in a transmission circuit arranged in a loop configuration.

3.2 conversational television programme: A television programme that contains live conversation contributions shot at different locations, linked together at a base location.

4 Background on loop latency in contribution circuit for conversational TV programmes

Television programmes can include interviews or other interactive situations which involve live conversational contributions shot at different physical locations, linked together at a base location.

Such live contributions to a television programme can suffer from time delays caused by the transport time of the signals themselves, or by their processing by means of compression algorithms used in the round-trip circuits from and to the base location. The total round-trip time delay is often called "loop latency".

Excessive loop latency can be annoying and it can even make the resulting conversational television programme subjectively unacceptable.

5 Results of subjective assessment tests on the perceptual impact of loop latency

Recent subjective assessment tests performed by RAI in Italy in the framework of the activity of the EBU have addressed the subjective impact of loop latency on the appreciation of the quality of a conversational television programme, and the value that loop latency should desirably not exceed in such an environment, which is typical of television news. (See Appendix I.)

The tests were based on an emulation of a conversational programme. They involved:

- 15 administrative RAI employees as non-expert assessors that participated in the conversation;
- 2 journalists as expert assessors that participated in the conversation.

The test used the 5-grade impairment scale of ITU-R Rec. BT.500. It is recalled that grade 5 of that scale corresponds to an imperceptible impairment, while grade 1 corresponds to a very annoying impairment.

Figure 1 shows the average scores of those expert and non-expert assessors, for various values of loop latency.

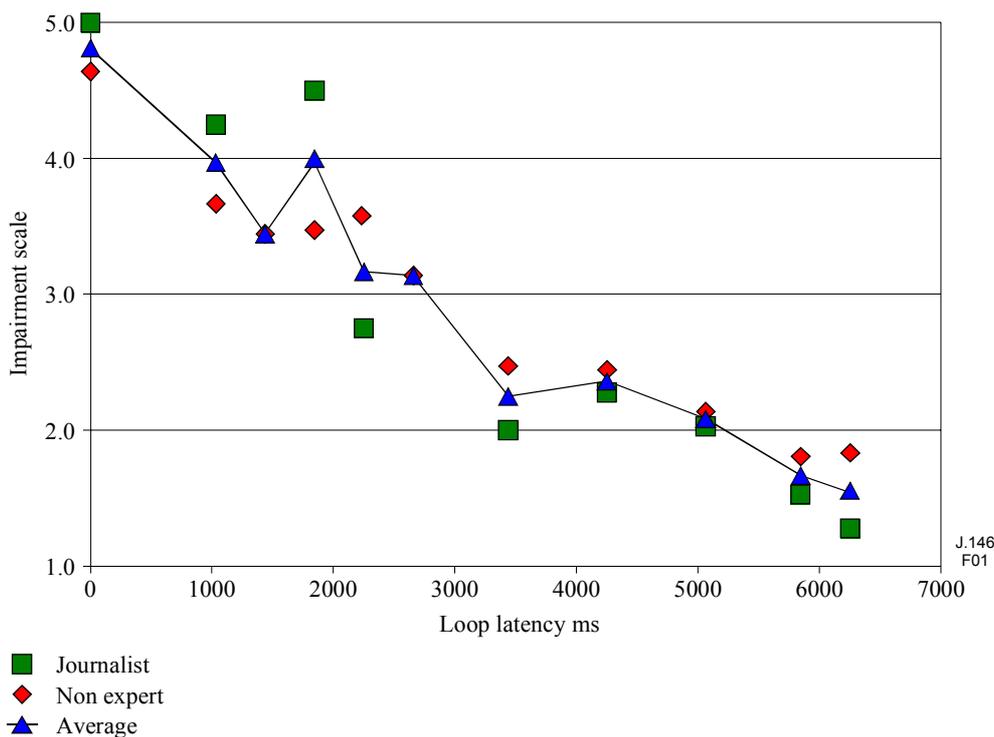


Figure 1/J.146 – Average scores obtained using the 5-grade impairment scale of ITU-R Rec. BT.500

It is seen that a 3.5 grade impairment (between "perceptible but non-annoying" and "slightly annoying") is reached for a loop-latency value of around 1.5 to 2 s.

The flex in the average score curve (at approximately 1.8 s) is currently attributed to a subconscious transition of participating assessors from the true conversational mode to a "question and answer" mode that was observed to occur when the loop latency exceeded the value that would permit a fully comfortable conversation.

6 Conclusions on tolerable loop latency in conversational television programmes

The results of the described preliminary subjective assessment tests appear to indicate that the acceptability threshold for loop latency is between 1.5 and 2 s in a complex television news environment with A/V conversations between remote correspondents and an anchorman in the main news studio.

The results of the tests briefly described in Appendix I need to be confirmed by means of additional, more extensive tests. However those results already show that loop latency may represent a serious problem for television programmes that are based on a conversation among participants placed in different physical locations, linked together at a base location. The influence of excessive programme chain loop latency on the perceived quality of the television programme should be kept in mind when conversational television programmes are designed.

The problem is certainly not negligible, since digital transmission chains set up for conversational television programmes are generally quite complex and they are likely to contain a good number of digital codecs, each one contributing its own latency to the overall loop latency.

One should consider in this respect that MPEG-2 DSNG codecs operating at 9 Mbit/s in their minimum-delay mode may each have a latency between 250 and 500 ms or higher, depending on

the brand, the model and the used GOP. This means that a digital chain that includes as few as four 9 Mbit/s MPEG-2 codecs might already display excessive loop latency, even if the codecs are carefully selected for minimum latency and there are no other causes of latency in the chain, such as satellite links.

Appendix I

Summary report on RAI's tests on the impact of loop latency

Background

New Question [21/9] that the last WTSA has assigned to ITU-T Study Group 9 notes, among several aspects of quality, the fact that "in a free conversation through a videophone the perceived quality may primarily depend on delay, lip-synchronisation and audio quality".

In the framework of the studies that Study Group 9 may perform in relation to this aspect of Question [21/9], it may usefully consider the information provided in this appendix, which is based on subjective tests that RAI has performed in Italy on the subjective impairment due to loop latency in television programmes that rely on a conversation among parties located in widely separated locations. Those tests fall in the framework of recent EBU studies on the performance of digital television programme production chains. They require further validation, but they already provide useful insight on the magnitude of loop latency that can be expected in real-life situations, and on its effects on the perceived quality of conversational television programmes.

I.1 Introduction

Television programmes can include interviews or other interactive situations which involve live conversational contributions shot at different physical locations, linked together at a base location.

Such live contributions can suffer from time delays caused by the transport time of the signals themselves, or by their processing by means of compression algorithms used in the contribution circuits to and from the base location. This "round-trip" time delay is designated here as "loop latency".

Excessive loop latency can be annoying and it can make the resulting conversational programme subjectively unacceptable. Therefore it is necessary to study the subjective impact of loop latency and to specify appropriate limits for it.

The Research Centre of RAI in Turin, Italy has studied the problem of loop latency, both in terms of its expected magnitude in a typical digital television news environment, and in terms of its impact on perceived programme quality, in view of proposing requirements for its maximum value.

I.2 The impact of loop latency on perceived programme quality

In order to assess the impact of loop latency on perceived quality of a conversational television programme, RAI has performed a subjective assessment test, involving 15 administrative employees of RAI as non-expert "active" assessors and two RAI journalists as expert assessors (site A and B). It also involved 12 administrative employees of RAI as "passive" or "external" assessors (site C).

The test was performed using a test bed based on the conceptual diagram of Figure I.1, in which the signal delay could be adjusted in 200 ms and 400 ms increments with the minimum delay of 520 ms.

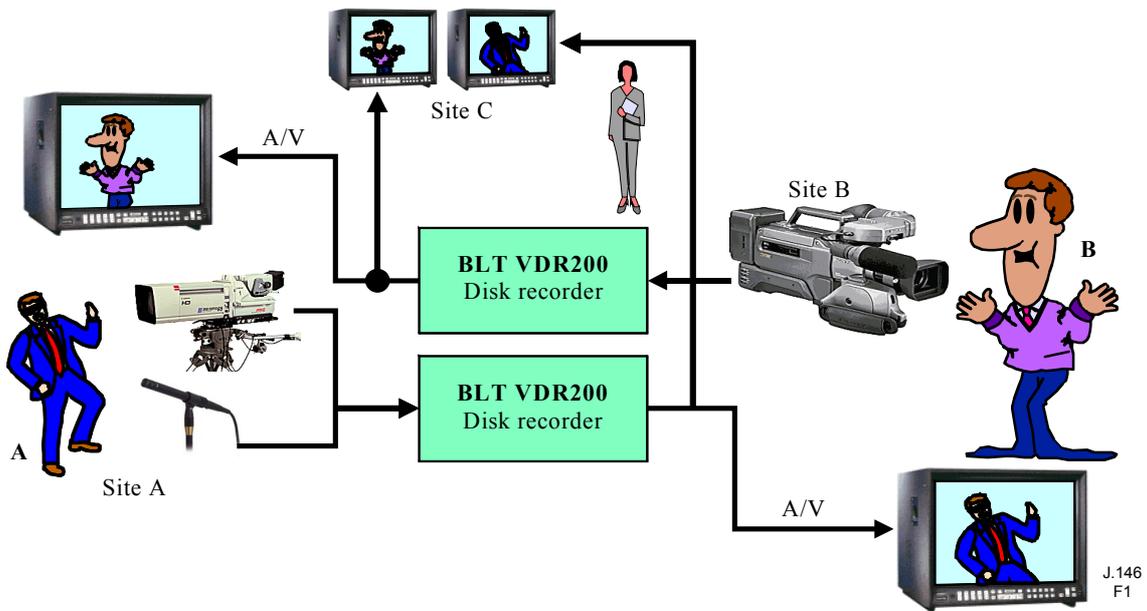


Figure I.1/J.146 – Conceptual diagram of the subjective assessment test bed

Two "active" assessors, placed at positions A and B, held a 2-minute conversation at a set value of delay. The same values of delay were used twice during the experiment to check the stability of the methodology. This was a blind test since the assessors were not told the amount of delay.

At the end of each 2-minute conversation both active assessors were asked to score the acceptability of the A/V communication ticking a YES or a NO box. They were also asked to score the A/V communication on the usual 5-grade impairment scale of ITU-R Rec. BT.500, bearing on mind the effect of the delay. It is recalled that the 5-grade scale carries the scores:

- 5 – imperceptible
- 4 – perceptible but not annoying
- 3 – slightly annoying
- 2 – annoying
- 1 – very annoying.

During the conversation of the active assessors, a group of "passive" or "external" assessors watched the conversation on two displays in a further position C, but the scores they provided are not relevant to this Recommendation.

Table I.1 provides the average scores for the test with active assessors. It also provides the values of standard deviations, thus giving an idea of the reliability of the test.

Table I.1/J.146 – Average scores and standard deviations for active assessors

Latency (ms)	Average score	Standard deviation
0	4.63	0.49
1040	3.67	0.80
1440	3.43	0.90
1840	3.47	0.86
2240	3.57	1.04
2640	3.13	1.01

Table I.1/J.146 – Average scores and standard deviations for active assessors

Latency (ms)	Average score	Standard deviation
3440	2.47	0.86
4240	2.43	1.10
5040	2.13	0.90
5840	1.80	0.55
6240	1.80	0.85

Figure I.2 provides the plot of those average scores.

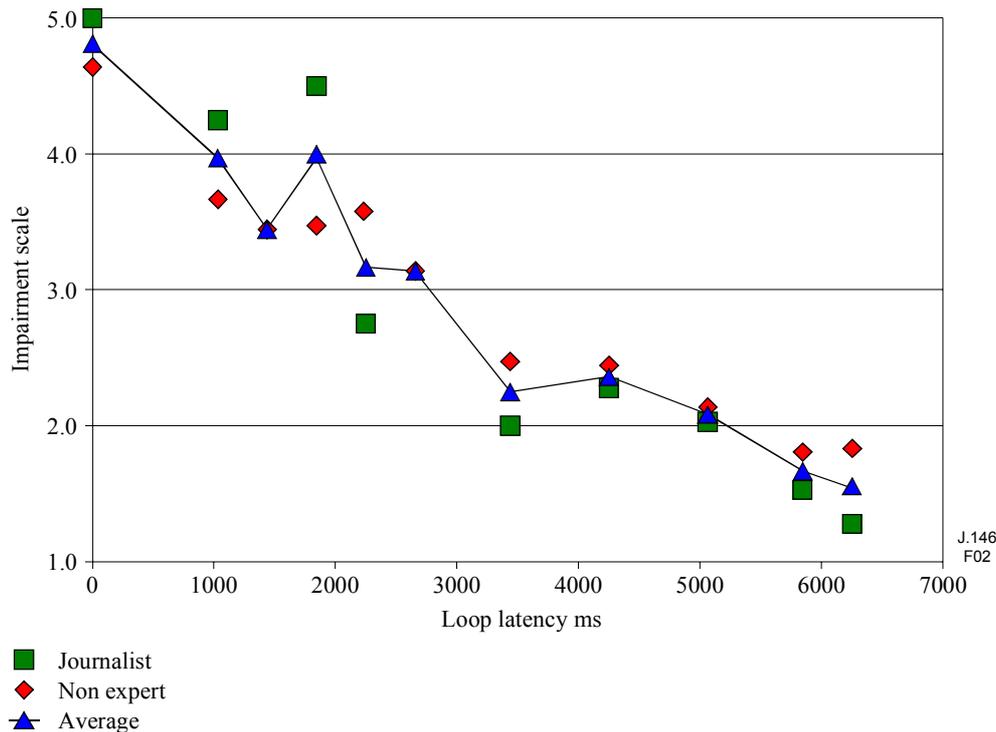


Figure I.2/J.146 – Average scores obtained using the 5-grade scale

In conventional subjective assessment tests based on the use of the 5-grade scale of ITU-R Rec. BT.500, the acceptability threshold for an impairment is sometimes set at an average score of 3.5, namely when 50% of the assessors consider that the impairment is annoying and 50% of the assessors perceive it but consider that it is not annoying.

If this principle can be applied to the test on loop latency, then the acceptability threshold would fall in the vicinity of 1.5 or 2 s¹.

I.3 Expected magnitude of loop latency in a television news environment

In order to estimate the expected magnitude of loop latency in a complex television news production environment, the signal delay through five different brands of MPEG DSNG codecs was measured in their various modes of operation (the total expected loop latency is the sum of the

¹ The flex in the average score curve is currently attributed to a subconscious transition of participating assessors from the true conversational mode to a "question and answer" mode that occurs when the loop latency exceeds the value that would permit a fully comfortable conversation.

individual delays of all the codecs in the loop). As a reference, the delay through an ETSI codec was also measured. The value of PSNR (Peak Signal to Noise Ratio) for the sequence "Mobile & Calendar" was measured as well.

The results confirm that MPEG codecs generally provide a delay larger than that of an ETSI codec. They also confirm that the introduction of several MPEG codecs in tandem in a typical television news chain may well cause problems with excessive loop latency.

I.4 Conclusions

The results of the described subjective assessment tests indicate that the acceptability threshold for loop latency is between 1.5 and 2 s in a complex television news environment with A/V conversations between remote correspondents and an anchorman in the main news studio.

The intrinsic signal delay, measured on five brands of MPEG codecs in their various modes of operation, appears to indicate that loop latency may often exceed that acceptability threshold in some complex programme production situations, such as it is the case of news programmes that involve A/V conversations with remote participants.

It would be useful to validate these preliminary results with further studies performed with a larger number of non-expert and expert assessors and on a larger number of MPEG codecs in various modes of operation.

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