INTERNATIONAL TELECOMMUNICATION UNION

ITU-T U.23

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

TELEGRAPH SWITCHING

SIGNALLING OVER RADIO AND MULTIPLEXED CHANNELS

USE OF RADIOTELEGRAPH CIRCUITS WITH ARQ EQUIPMENT FOR FULLY AUTOMATIC TELEX CALLS CHARGED ON THE BASIS OF ELAPSED TIME

ITU-T Recommendation U.23

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation U.23 was published in Fascicle VII.2 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

2 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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(Mar del Plata, 1968; amended at Geneva, 1972)

1 Charging on the basis of elapsed time

Where a radiotelegraph circuit equipped with ARQ equipment forms part of an international telex network and can be engaged in a telex connection established by fully automatic switching, the Administrations are faced with a difficult problem regarding automatic charging of the calls. The difficulty arises from the fact that in case of bad transmission conditions on the radiotelegraph circuit, signals recognized as erroneous are repeated. These repetitions can be numerous at certain times. For manual or semi-automatic operation, in order to establish the basis for charging, the Administrations or recognized private operating agencies (RPOA) deduct the time during which the circuit has been transmitting repetitions from the elapsed duration of the connection.

The application of this method to fully automatic calls – although desirable – is made difficult by the fact that the charge for these calls is made in the originating country and by automatic methods. When the call is not established through the intermediary of radiotelegraph circuits incorporating ARQ equipment, the charge is made according to the elapsed time of the communication. It would then be necessary to advise the originating country that the call has involved a radiotelegraph circuit that incorporates ARQ equipment, and to advise what correction should be applied to the elapsed time of the communication in order to account for the periods of inefficiency of the radiotelegraph circuit.

Some study has been made for finding a solution that is both technically and economically acceptable for the transmission and use of information necessary for corrected charging as a function of the inefficiency of the radiotelegraph circuit. However, due to the declining importance of radio circuits incorporating ARQ equipment for fully automatic traffic in the telex network and the tendency for them to be relegated to the role of standby circuits, further study of the method of charging based upon efficient time has been abandoned.

The alternative solution of charges based upon elapsed time has now been adopted as the standard to be applied. It will then be necessary before incorporating a circuit with ARQ equipment in the fully automatic telex service to ensure that it meets with certain stability requirements. Safeguard measures designed to avoid, in certain cases, an excessive overcharge of the calling subscriber, as indicated in the present Recommendation, will be necessary.

2 Safeguard measures

When charges are to be based on elapsed time, the methods of safeguard are:

i) busying of an unoccupied radiotelegraph channel whenever transmission conditions on this channel are inadequate;

ii) forced release of an established connection on such a channel whenever transmission conditions are bad.

In the application of the latter type of safeguard (forced release of an established connection), there are two conflicting requirements:

i) the need to avoid substantial differences between the charged time and the time during which the connection was efficient;

ii) the need to avoid, as much as possible, forced release of established connections.

A reasonable compromise solution should achieve the following main objectives:

i) the percentage of forced releases must not exceed three;

ii) the average overcharge for a call must not exceed five per cent;

iii) the maximum overcharge for a call must not exceed twenty-five per cent.

3 Control of forced release

Administrations employing radiotelegraph circuits incorporating ARQ equipment should use the efficiency factor for controlling the forced release of an established connection. With this arrangement, an established connection will be cut whenever the efficiency factor, averaged over 60 consecutive seconds, falls below 80%. This form of control, especially if it is applied to circuits that conform to the stability requirements specified in § 9 below, ought not to result in more than two or three per cent of connections being interrupted; this figure is quite comparable with the number of fortuitous releases recorded in the use of cable circuits.

4 Control of busying

At those times when its efficiency factor is too low, a circuit that is not carrying traffic should be busied at both ends so that it cannot be seized by a call until such time as the efficiency factor reverts to an acceptable value. The circuit will be busied if the mean value of the efficiency factor, measured over an interval of 20 consecutive seconds, is less than 80%.

5 Practical application of busying

For a radiotelegraph system corresponding to 50 bauds (see Recommendation S.13 [1]), the maximum number of transmissible elements in a 20-second period is 20×48 and the corresponding number of characters is $(20 \times 48)/7$ i.e. 137. If r is the number of repetition cycles during 20 seconds, the efficiency factor is $(137 - 4^{1)}\ r)/137$. Hence, it is sufficient to count the number of repetition cycles because if, in a period of 20 consecutive seconds, there are $7^{2)}$ repetition cycles or more, then the mean efficiency factor is below 80% during that period.

The two most practical methods of dividing the time up into intervals of 20 seconds are the procedure of splitting the time into 20-second blocks and the method of using sliding periods of 20 seconds.

In the procedure of splitting the time into blocks, the time is divided into fixed intervals of 20 seconds. The repetition cycles are counted during each of these intervals and the count is recommenced for each interval, no account being taken of the result of the count for the preceding interval. In the sliding period method, the earliest count is eliminated and a new count added.

The block method uses simpler equipment than the sliding period method; it is a little less exact because of the fact that the influence of a bundle of repetitions arriving at about the same time as the division between successive blocks is spread over two successive and independent blocks.

After very close consideration of the discrepancies between the results given by the two methods, it was concluded that the effect of these discrepancies is small and of no practical importance as far as subscribers are concerned. Administrations may therefore select either method.

If, during a counting period, the number of repetition cycles has already reached a figure corresponding to a mean efficiency factor of lower than 80% over the 20-second period, the decision to order busying of the circuit will be made immediately, without waiting for the end of the current 20-second period.

The manner in which the order to busy the circuit is sent from the ARQ equipment to the switching centre is a matter that interests only the Administration that operates the centre and the ARQ equipment to issue an international recommendation on this matter.

The timing of intervals at the two ends of the same circuit is not synchronized, so that instants of busying or debusying a circuit at one end may differ from the corresponding instants at the other end by several seconds. As a result, while one end of the circuit is marked busy, a call can seize the circuit at the other end. This situation is considered as admissible, and the incoming call is accepted.

After a circuit is marked busy, the measurement of the efficiency factor proceeds in accordance with the same time-division process. If, during a 20-second period, the mean efficiency factor reaches or exceeds 80%, the busy marking is removed. It follows that, whenever the efficiency factor is varying at about 80%, periods of busying and of return to service can succeed one another at intervals of about 20 seconds. This effect was considered to be permissible.

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1) This figure is 8 in the case of an 8-character-repetition cycle.

2) 3.5 with an 8-character-repetition cycle.

6 Application of forced release

A call can seize the radiotelegraph circuit only during a period when the circuit is not marked busy. In the case of a call's arriving on the radiotelegraph circuit after the occurrence of the first marker denoting the termination of a 20-second period, the time division will proceed on the basis of 60-second intervals (instead of 20-second ones), and everything that has been said about 20-second periods applies equally to 60-second periods. In particular if, during a 60-second period, it is already evident that the efficiency factor cannot reach an average value of at least 80%, forced release of the connection shall be ordered without waiting for the end of the period.

If the efficiency falls so far that the connection must be cut at the calling end of the ARQ circuit, a long time could elapse, in the event of very adverse transmission conditions, before the release signal could be sent to the called subscriber. Consequently, the called subscriber (especially in stations not supervised by a receiving operator) remains engaged and cannot be reached by other subscribers. Also, the re-establishment of the call by way of another channel becomes impossible. Therefore, it is desirable to be able to effect a release at the receiving end in unfavourable conditions. The method of release employed at the receiving end, however, should not initiate release more easily than at the calling end. It is proposed for this purpose that, once there is evidence at the receiving end that the mean efficiency factor has remained lower than 80% for two successive 60-second periods, release at the receiving end should follow.

7 Elimination of signals still registered in the memory

Once the decision has been made to break the established connection at either end, the signals that are still recorded in the ARQ equipment memory must be destroyed. It must be pointed out that in this case the forced release signal has been due to the bad transmission conditions; it is very probable that the subscriber, at the receiving end, will be released by the auxiliary safeguard measures (two successive periods of 60 seconds with the efficiency factor below 80%); the signals that the memory would continue to dispose of in the forward direction will probably not reach the called subscriber. For this reason the elimination of the signals still registered in the memory has been decided.

8 Advising the calling subscriber

It has been proposed that the calling subscriber should be advised by a special service signal preceding the forced release signal; in this way the calling subscriber would know that he must reforward his whole message. This service signal would above all have the advantage of enabling the automatic charging device to recognize that it is dealing with a connection that has been interrupted as a result of operation of the safeguard feature of an ARQ equipment and that the call must not be charged.

Although the principle of this solution may have escaped critiscism, its application has provoked objections. The first would be the cost and complexity of equipment that would ultimately be used for only a very small proportion of calls. Another objection would be the fact that, in certain types of apparatus, automatic transmission could not be interrupted by the reception of signals; the only result would be mutilation on the local copy of the transmitted text and of the service code; the meaning of these mutilations could be obscure to the subscriber. The aspect of the other end of the communication, which could also have a message in the process of transmission to the calling subscriber, must also be taken into account. Finally, the use of the clearing signal only, without the use of a preliminary service signal, was proposed.

9 Precautions to be taken before incorporating circuits with ARQ equipment in automatic switching networks

In spite of these precautions, fully-automatic operation on a radiotelegraph circuit incorporating ARQ equipment can be considered only if this circuit possesses adequate stability.

Before incorporating a circuit with ARQ equipment in the fully-automatic switching network, the Administrations must carry out extended trials. These trials should be made under normal traffic conditions, over a minimum period of three consecutive hours chosen from the busy period (or periods), when heavy traffic is foreseen to occur on the route under consideration (allowing for the traffic, whether terminal or transit, that prevails on the route according to the season). The condition that must be fulfilled before a circuit can be accepted for use in the fully-automatic network is that its mean efficiency factor, measured over periods of 20 consecutive seconds each, shall not fall below 80% for more than 10% of the total time involved in the measurements. The measurements must be repeated as often as will be necessary for the Administration to have an assessment of the suitability of the circuit.

The attention of Administrations is drawn to the fact that, before offering fully-automatic transit working on a radio route incorporating ARQ equipment, the grade of service on the route under consideration must be in accordance with that proposed in Recommendation F.68 [2], i.e. only one call lost in 50.

If these conditions are not complied with, it would be better to retain semi-automatic operation.

For these reasons, the CCITT

unanimously declares the following view

(1) Administrations operating radiotelegraph circuits equipped with ARQ systems that may be engaged in a fully-automatic telex call, such that the charging of the subscriber is made automatically in the originating country according to the elapsed time of the connection, must take precautions to avoid too great a difference between the charged time and the time during which the radiotelegraph circuit was efficient.

(2) If, in the course of an established connection, the mean value of the efficiency factor[3]) is lower than 80% over a period of 60 consecutive seconds, the connection will be released and the clearing signal will be sent to the calling subscriber under the control of the ARQ equipment.

(3) For a circuit involved in a fully automatic telex network, measurements will be made, at those times when the circuit is not held by a call, in order to determine the mean efficiency factor based on periods of 20 consecutive seconds. If, during such a period, the mean efficiency factor falls below 80%, the circuit shall be marked busy on the first switching centre located backward of the ARQ equipment that assessed this situation. If, during a period of 20 consecutive seconds, the mean efficiency factor rises above 80%, the busy marking shall be removed and the circuit will be able to be seized by a call.

(4) Interruption of an established connection will occur, at the calling side when, during a 60-second period, it becomes apparent, without waiting until the end of the period, that the mean efficiency factor during the period will be lower than 80%. If, at the called side, the mean efficiency factor during two consecutive periods of 60 seconds is lower than 80%, the release of the connection will be given to the called end.

(5) In case of a forced release of the connection, the clearing signal will be sent to the calling end (and eventually to the receiving end) from the ARQ equipment. The signals that would still be stored in the memories at the moment of the sending of a forced release signal will be destroyed. Stop polarity will be transmitted across the radiotelegraph circuit while the store is being destroyed.

(6) In the case where two or more radio circuits using ARQ equipment would be used in tandem on a connection, each circuit will operate on its own, independently of the conditions on the other circuit(s).

References

[1] CCITT Recommendation *Use on radio circuits of 7-unit synchronous systems giving error correction by automatic repetition*, Rec. S.13.

[2] CCITT Recommendation *Establishment of the automatic intercontinental telex network*, Rec. F.68.

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3) **efficiency factor in time** is defined as:
The ratio of the time necessary to transmit a text automatically without repetition, at a specified modulation rate, to the time actually taken to receive the same text with a given error rate.

Note 1– The whole of the apparatus comprising the communication is assumed to be in the normal conditions of adjustment and operation.

Note 2 – A telegraph communication may have a different efficiency factor in time for the two directions of transmission.

Note 3 – The actual conditions in which the measurement is made should be specified, in particular the duration of the measurement.