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SERIES K: PROTECTION AGAINST INTERFERENCE

Interference management for telecommunication transmissions over copper lines for signals other than speech

Recommendation ITU-T K.146

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Interference management for telecommunication transmissions over copper lines for signals other than speech

Summary

Recommendation ITU-T K.146 deals with the management of electromagnetic interference produced by electrified railway traction systems on telecommunication systems in DSL frequency bands.

This Recommendation defines only a procedure to evaluate the acceptability of an electromagnetic DSL draft interference and gives:

– the criteria defining the quality of service that has to be reached;

– the limits of the commercial ADSL offer guaranteed by an Internet service provider in conjunction with a telecommunication operator if necessary, in the vicinity of a potentially obstructive railway;

– the installation conditions of electrified traction and telecommunication systems under which the Recommendation applies.

This Recommendation helps to establish a contract between Internet service providers in conjunction with telecommunication operators, if necessary, and railway operators in order to clearly share responsibilities, and, as a consequence, and if necessary, the relevant expenses for mitigation measures.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Keywords

ADSL, disturbance, noise margin, QoS, rate.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Introduction

Recommendation ITU-T K.68 to which this Recommendation refers is limited to the audible frequency range (300-3 400 Hz). Since then, ADSL telecommunication technology has appeared and railway traction generating electromagnetic interference in the concerned frequency band has improved; therefore, it has been highlighted that a complement to Recommendation ITU-T K.68 was needed to take these new interactions into account.

This Recommendation aim is to define a framework to deal with these interferences in ADSL frequency bands, the specific cases and the acceptable limits for both parties, and a method of measurement and mitigation of electromagnetic interferences in the 22.875 kHz – 2 208 kHz range.

Recommendation ITU-T K.146

Interference management for telecommunication transmissions over copper lines for signals other than speech

1 Scope

This Recommendation deals exclusively with copper links with lengths greater than 1000 m as a medium for ADSL services. As a consequence of attenuation brought by lengths superior to 1000 m, it is not possible to set up a DSL service other than with ADSL, which can be sensitive to electromagnetic interference generated by railway electric traction systems in the vicinity.

This Recommendation shall cover alternative current traction systems located less than 1000 m from the ADSL link. Direct current traction systems are not covered by this Recommendation.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T K.68] Recommendation ITU-T K.68 (2008), *Operator responsibilities in the management of electromagnetic interference by power systems on telecommunication systems*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 attenuation or loss [b-ITU-R V.574-5]: The attenuation or loss is a decrease between two points of an electric, electromagnetic or acoustic power. The attenuation is also the quantitative expression of a power decrease expressed by the ratio of the values at two points of a power or of a quantity related to power in a well-defined manner. This ratio is generally expressed in decibels.

3.1.2 attenuation range (aH) [b-ITU-T P.502]: Range in dB of attenuation inserted in sending or receiving direction of a terminal or system.

3.1.3 bitrate [b-ITU-T H.262]: The rate at which the coded bitstream is delivered from the storage medium to the input of a decoder.

3.1.4 noise margin [b-ITU-T G.993.1]: The maximum amount by which the reference noise level can be increased during a BER (bit error rate) test without causing the modem to fail the BER requirement.

3.1.5 quality of service [b-ITU-T Q.1743]: The collective effect of service performances, which determine the degree of satisfaction of a user of a service. It is characterized by the combined aspects of performance factors applicable to all services, such as:

– service operability performance;

– service accessibility performance;

– service retainability performance;
– service integrity performance; and
– other factors specific to each service.

3.1.6 synchronization: All definitions related to synchronization are contained in [b-ITU-T G.810], [b-ITU-T G.8260] and [b-ITU-T G.781].

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ADSL Asynchronous Digital Subscriber Line

DSL Digital Subscriber Line

DSLAM Digital Subscriber Line Access Multiplier

NM Noise Margin

QoS Quality of Service

5 Conventions

None.

6 Procedure to manage electromagnetic interference

This Recommendation aims to define the acceptable quality of service (QoS) for the ADSL links defined in the scope. Three situations are retained:

1 compliance with the minimal QoS defined by the Internet service provider in conjunction with a telecommunication operator, if necessary;

2 downgrade of the link with apparition of errors;

3 loss of synchronization (loss of service).

When a connection is established between customer equipment and an Internet service provider DSLAM, the ADSL protocol sets up the actual rate and noise margin (NM) according to the Internet service provider's policy regarding the neighbouring conditions that exist at that very moment.

An ADSL link running at maximum rate and therefore at minimum NM is not statistically representative of a general case, as ADSL links under the scope of this Recommendation establish with higher NM so that a reliable service remains available for the customer. This Recommendation aims to define the minimal QoS, under which there has to be an agreement between an Internet service provider in conjunction with a telecommunication operator, if necessary, and a railway operator regarding the measures to be taken to fix the consequences of electromagnetic interferences generated by the alternative current traction system of the railway.

These electromagnetic interferences have to last for a minimum duration. Indeed, ADSL protocol allows a certain downgrade of the link before an established connection is lost. In practice, in electrified railways, the train circulation over an electric sector in a vicinity of ADSL links on copper medium lasts several minutes, which can be sufficient for the ADSL service to gradually worsen (transmission errors, frozen pixels on the TELEVISION service, distorted sound…) before the link is desynchronized. This Recommendation proposes topologies of disturbances derived from field

measurements, allowing us to temporally describe a classic railway disturbance in the ADSL frequency range (especially the harmonic spectrum of the traction system fundamental).

Based on the scope of this Recommendation, it should be then possible to define various quality of ADSL service levels that can be guaranteed by an Internet service provider in conjunction with a telecommunication operator, if necessary, in a disturbed environment. Regarding the rate set up upon synchronization, intrusion of railway disturbance in the corresponding noise margin can lead to various impacts:

- no loss of service (transmission errors are limited and corrected real-time by the set-top box);
- transmission errors, perceptible by the customer as the TELEVISION images become frozen, sound is distorted, internet loading is longer than usual…;
- loss of synchronization, generally occurring after the previous point, as harmonic spectrum of the railway disturbance and its duration are long and powerful enough.

After desynchronization, the customer set-top box will try to synchronise again with the Internet service provider DSLAM, taking a slower rate and higher NM so to be more immune to disturbances.

This is allowed downwards until a certain point; under which the QoS will be considered as unreached; or unreachable in the very disturbed areas. This Recommendation should then apply.

So far, this Recommendation should be regarded as a template for helping any ADSL Internet service provider in conjunction with a telecommunication operator, if necessary, to agree with any railway operator of a neighbouring electrified line upon a document stating which minimal QoS is relevant to be reachable, the means of mitigation that can be undertaken, and the sharing of costs that can be performed.

Numerical values, means of measurement, stopgap solutions (better shielded cables, diversion of the link path, conversion to optical fibre link,…), work or cost share schemes, are left to the responsibility of the concerned parties, as the wide variety of devices, situations, disturbances, and minimal QoS an Internet service provider in conjunction with a telecommunication operator, if necessary, can choose to guarantee their customers does not allow for a summary in such a Recommendation.

This approach should be the best to ensure a realistic and efficient treatment of disturbances coming from an electrified railway upon ADSL links on the scope, as the ADSL technology is much more varied and dynamic than the audible range treated in [ITU-T K.68], which this Recommendation proposes to complement.

Annex A

Illustration of the principle of a working ADSL link on copper medium regarding a minimal QoS ensured in a disturbed environment

(This annex forms an integral part of this Recommendation.)

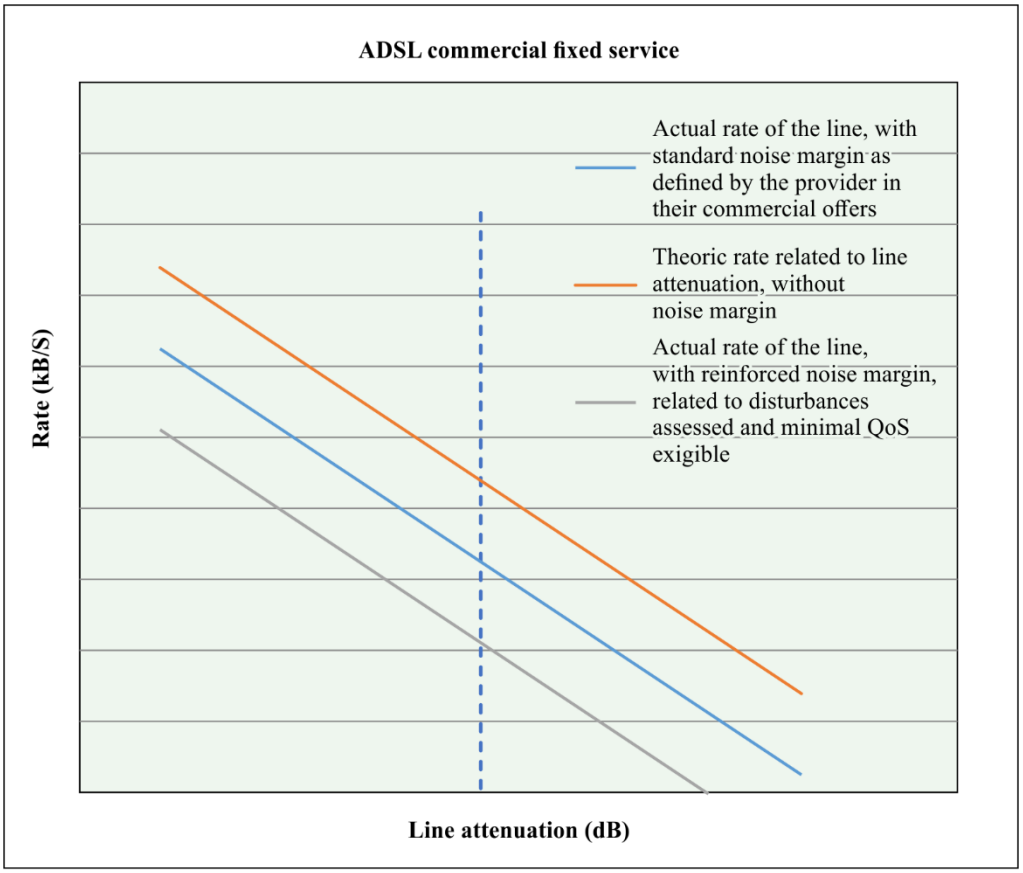

Figure A.1 – Illustration of the principle of a working ADSL link on copper medium regarding a minimal QoS ensured in a disturbed environment

For a given line attenuation, we have three possible rates, according to which level of disturbance the link is exposed to. If it is proven that the link has been exposed to electric railway disturbances, then the agreement between both operators can set the value of the reinforced NM curb so the service remains available without falling under a certain rate.

If not possible, engineering and civil works should be carried out to replace the link exposed to the too severe disturbance.

This figure does not show any value of line attenuation or rate, it also does not specify the type of ADSL service because each country does not have the same telecommunication lines and services.

This figure only focus on how the noise margin increases when the rate of the telecommunication line decreases.

Bibliography

[b-ITU-T G.781] Recommendation ITU-T G.781 (2020), *Synchronization layer functions for frequency synchronization based on the physical layer*.

[b-ITU-T G.810] Recommendation ITU-T G.810 (1996), *Definitions and terminology for synchronization networks.*

[b-ITU-T G.993.1] Recommendation ITU-T G.993.1 (2004), *Very high speed digital subscriber line transceivers (VDSL).*

[b-ITU-T G.8260] Recommendation ITU-T G.8260 (2020), *Definitions and terminology for synchronization in packet networks.*

[b-ITU-T H.262] Recommendation ITU-T H.262 (2012) | ISO/IEC 13818-2:2013, *Information technology – Generic coding of moving pictures and associated audio information: Video.*

[b-ITU-T P.502] Recommendation ITU-T P.502 (2000), *Objective test methods for speech communication systems using complex test signals.*

[b-ITU-T Q.1743] Recommendation ITU-T Q.1743 (2016), *IMT-Advanced references to Release 11 of LTE-Advanced evolved packet core network.*

[b-ITU-R V.574-5] Recommendation ITU-R V.574-5 (2015), *Use of the decibel and the neper in telecommunications.*

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