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GENERAL ASPECTS OF DIGITAL TRANSMISSION SYSTEMS

VOCABULARY OF DIGITAL TRANSMISSION AND MULTIPLEXING, AND PULSE CODE MODULATION (PCM) TERMS

ITU-T Recommendation G.701

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The 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 Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation G.701 was revised by the ITU-T Study Group XV (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

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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Recommendation G.701**VOCABULARY OF DIGITAL TRANSMISSION AND MULTIPLEXING,
AND PULSE CODE MODULATION (PCM) TERMS***(Melbourne, 1988; revised at Helsinki, 1993)***1 Introduction**

This Recommendation provides a vocabulary of terms and definitions that are appropriate to digital and pulse code modulation multiplexing and transmission systems.

A small number of the terms in the Recommendation are duplicated in Recommendation I.112. References to these definitions are given in parenthesis as an aid to ensuring consistency between the two Recommendations in the event of future amendments.

According to the conventions applied in this Recommendation any term in common usage, but whose use is deprecated in the sense defined, is shown after the recommended term as in the following example: "2026 controlled slip [slip]".

Where a truncated term is widely used in an understood context the complete term is quoted following the colloquial form, for example: "1007 circuit, telecommunication circuit".

Furthermore, any term which is in general use in addition to the principal term is shown after the principal term as in the following example: "6002 timing recovery (timing extraction)".

In the interest of standardization in the drafting of documents the following abbreviations are recommended:

kbit/s;

Mbit/s;

Gbit/s.

To avoid misinterpretation of the use of the point (.) and the comma (,) in different languages to separate the whole and decimal parts, it is recommended that the use of decimals should be avoided wherever possible. For example, "2048 kbit/s" is preferred to "2.048 Mbit/s" or "2,048 Mbit/s".

Annex A to this Recommendation contains an alphabetical list of all of the terms defined in this Recommendation.

Appendix I to this Recommendation contains a list of abbreviations used in G-, H- and J-Series Recommendations.

2 Vocabulary of digital transmission and multiplexing and pulse code modulation terms (PCM)**2.1 General**

For the purposes of this Recommendation, the following definitions apply.

1001 signal [102]

F: signal

S: señal

A physical phenomenon one or more of whose characteristics may vary to represent information.

1002 analogue signal [103]

F: signal analogique

S: señal analógica

A signal one of whose characteristic quantities follows continuously the variations of another physical quantity representing information.

1003 discretely-timed signal [104]*F: signal (temporel) discret**S: señal discretamente temporizada*

A signal composed of successive elements in time, each element having one or more characteristics which can convey information, for example, its duration, its waveform and its amplitude.

1004 transmission [106]*F: transmission**S: transmisión*

The action of conveying signals from one point to one or more other points.

NOTES

- 1 Transmission can be effected directly or indirectly, with or without intermediate storage.
- 2 The use of the English word "transmission" in the sense of "emission" is deprecated.

1005 channel, transmission channel [108]*F: voie, voie de transmission**S: canal, canal de transmisión*

A means of unidirectional transmission of signals between two points.

NOTES

- 1 Several channels may share a common path; for example each channel may be allocated a particular frequency band or a particular time slot.
- 2 The term may be qualified by the nature of the transmitted signals, by the bandwidth, by the digit rate, or by an arbitrary designation.
- 3 See also Recommendation I.112, Term 414, access channel.

1006 telecommunication [110]*F: télécommunication**S: telecomunicación*

Any transmission and/or emission and reception of signals representing signs, writing, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems.

1007 circuit, telecommunication circuit [111]*F: circuit, circuit de télécommunications**S: circuito, circuito de telecomunicación*

A combination of two transmission channels permitting bidirectional transmission of signals between two points, to support a single communication.

NOTES

- 1 If the telecommunication is by nature unidirectional (for example: long distance television transmission), the term "circuit" is sometimes used to designate the single channel providing the facility.
- 2 In a telecommunication network, the use of the term "circuit" is generally limited to a telecommunication circuit directly connecting two switching devices or exchanges, together with associated terminating equipment.
- 3 A telecommunication circuit may permit transmission in both directions simultaneously (duplex), or not simultaneously (simplex).
- 4 A telecommunication circuit that is used for transmission in one direction only is sometimes referred to as a unidirectional telecommunication circuit. A telecommunication circuit that is used for transmission in both directions (whether simultaneously or not) is sometimes referred to as a bidirectional telecommunication circuit.

1008 interface [408]*F: jonction (interface)**S: interfaz*

The common boundary between two associated systems.

1009 congestion*F: encombrement/engorgement**S: congestión*

Congestion is the conditions that exists in a network if the capacity needed for the instantaneous traffic exceeds the bandwidth available in the network.

2.2 Digital signals**2001 digit***F: élément numérique**S: dígito*

A member selected from a finite set.

NOTES

1 In digital transmission, a digit may be represented by a signal element, being characterized by the dynamic nature, discrete condition and discrete timing of the element, for example it may be represented as a pulse of specified amplitude and duration.

2 In equipment used in digital transmission, a digit may be represented by a stored condition being characterized by a specified physical condition, for example it may be represented as a binary magnetic condition of a ferrite core.

3 The context of the use of the term should be such as to indicate the radix of notation. (The meaning of "digit" in Notes 1, 2 and 3 translates into French as "élément numérique".)

4 In telephone subscriber numbering, a digit is any of the numbers 1, 2, 3 . . . 9 or 0 forming the elements of a telephone number (Recommendation Q.10 [1]). (This meaning of "digit" translates into French as "chiffre".)

2002 binary figure*F: chiffre binaire**S: cifra binaria*

One of the two figures (that is, 0 or 1) used in the representation of numbers in binary notation.

2003 binary digit (bit)*F: élément binaire (bit)**S: dígito binario (bit)*

A member selected from a binary set.

NOTES

1 Bit is an abbreviation for binary digit.

2 In the interest of clarity, it is recommended that the term "bit" should not be used in two-condition start-stop modulation instead of "unit element".

2004 octet*F: octet**S: octeto*

A group of eight binary digits or eight signal elements representing binary digits operated upon as an entity.

2005 code word [character signal]*F: mot de code [signal de caractère]**S: palabra de código [señal de carácter]*

A set of signal elements representing the quantized value of a sample in PCM.

NOTE – In PCM, the term "PCM word" may be used in this sense.

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2006 digital signal [105]*F: signal numérique**S: señal digital*

A discretely timed signal in which information is represented by a number of well-defined discrete values that one of its characteristic quantities may take in time.

NOTE – The term may be qualified to indicate the digit rate, for example: “140 Mbit/s digital signal”.

2007 signal element*F: élément de signal**S: elemento de señal*

A part of a digital signal, characterized by its discrete timing and its discrete value, and used to represent a digit.

2008 digit position*F: position d'un élément de signal, position d'un élément numérique**S: posición de dígito*

The position in time or space into which a representation of a digit may be placed.

2009 n-ary digital signal*F: signal numérique n-aire**S: señal digital n-aria*

A digital signal in which each signal element has one of n permitted discrete values.

2010 redundant digital signal*F: signal numérique redondant**S: señal digital redundante*

The signal that is produced by encoding a given signal in accordance with a redundant line code.

2011 redundant n-ary signal*F: signal n-aire redondant**S: señal n-aria redundante*

A digital signal whose elements can assume n discrete states where the average equivalent binary content per signal element is less than $\log_2 n$.

NOTE – The relative redundancy R , of an n -ary digital signal, is given by:

$$R = 1 - \frac{r_e}{r_d \cdot \log_2 n} = \left[1 - \frac{r_e}{r_d \cdot \log_2 n} \right] \cdot 100\%$$

where r_d is the symbol rate of the n -ary signal and r_e is the equivalent bit rate.

This may also be expressed in terms of the number of binary digits which can be transmitted by an element of a particular line code. Examples are:

AMI (37% redundant), 1 binary digit per element;

4B3T (16% redundant), 1.33 binary digit per element.

2012 pseudo n-ary signal*F: signal pseudo n-aire**S: señal pseudo n-aria*

A redundant n -ary digital signal that is derived from a m -ary digital signal without change of the line digit rate.

NOTE – An alternate mark inversion signal is an example of a pseudo-ternary signal, i.e. $n = 3$, $m = 2$.

**Documents**

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2013 digit rate

F: débit numérique
S: velocidad digital

The number of digits per unit time.

NOTES

- 1 An appropriate adjective may precede the word "digit", for example, binary digit rate.
- 2 In the interests of clarity it is recommended that this term should not be used to express the symbol rate on the line.

2014 line digit rate [symbol rate]

F: débit numérique en ligne [débit de symboles]
S: velocidad digital de linea [velocidad de símbolos]

The number of signal elements of the line signal transmitted per unit time.

NOTES

- 1 The baud is usually used to quantify this, one baud being equal to one single element per second.
- 2 Modulation rate is the term used in telegraphy and data communication; it is the reciprocal of the duration of the unit interval.

2015 equivalent binary content

F: contenu binaire équivalent
S: contenido binario equivalente

The number of binary digits strictly necessary to convey the same information as a defined number of signal elements in a given digital signal.

2016 equivalent bit rate

F: débit binaire équivalent
S: velocidad binaria equivalente

The value of the bit rate strictly necessary to convey the same information in the same time as a given digital signal at a given digit rate.

2017 significant instant, significant instant of a digital signal

F: instant significatif, instant significatif d'un signal numérique
S: instante significativo, instante significativo de una señal digital

The instant at which a signal element commences in a discretely-timed signal.

2018 unit interval

F: intervalle unitaire
S: intervalo unitario (o intervalo unidad)

The nominal difference in time between consecutive significant instants of an isochronous signal.

2019 decision instant, decision instant of a digital signal

F: instant de décision, instant de décision d'un signal numérique
S: instante de decisión, instante de decisión de una señal digital

The instant at which a decision is taken as to the probable value of signal element of a received digital signal.

2020 decision circuit

F: circuit de décision
S: circuito de decisión

A circuit that decides the probable value of a signal element of a received digital signal.

2021 regeneration*F: régénération**S: regeneración*

The process of receiving and reconstructing a digital signal so that the amplitudes, waveforms and timing of its signal elements are constrained within specified limits.

2022 regenerator*F: régénérateur**S: regenerador*

A device that performs regeneration.

2023 regenerative repeater*F: répéteur régénérateur**S: repetidor regenerativo*

A repeater that regenerates digital signals.

NOTES

1 A regenerative repeater may operate in one or both directions of transmission, and the term may be qualified by "unidirectional" or "bidirectional" as appropriate.

2 Repeater is defined in Recommendation G.601.

2024 jitter*F: gigue**S: fluctuación de fase*

Short-term non-cumulative variations of the significant instants of a digital signal from their ideal positions in time.

2025 wander*F: dérapage**S: fluctuación lenta de fase*

Long-term non-cumulative variations of the significant instants of a digital signal from their ideal positions in time.

2026 controlled slip [slip]*F: glissement commandé [saut]**S: deslizamiento controlado [deslizamiento]*

The irretrievable loss or gain of a set of consecutive digit positions in a digital signal, in which both the magnitude and instant of that loss or gain are controlled, to enable the signal to accord with a rate different from its own.

NOTE – Where appropriate the term may be qualified, for example: controlled octet slip, controlled frame slip.

2027 uncontrolled slip*F: glissement non commandé**S: deslizamiento incontrolado*

The loss or gain of a digit position or a set of consecutive digit positions in a digital signal resulting from an aberration of the timing processes associated with transmission or switching of a digital signal, and in which either the magnitude or the instant of that loss or gain is not controlled.

2028 scrambler*F: embrouilleur**S: aleatorizador*

A device that converts a digital signal into a pseudo-random digital signal having the same meaning and the same digit rate.

2029 descrambler

F: désembrouilleur
S: desaleatorizador

A device that performs the complementary operation to that of a scrambler.

2030 error, digital error

F: erreur, erreur numérique
S: error, error digital

An inconsistency between a digit in a transmitted digital signal and the corresponding digit in the received digital signal.

2031 error ratio [error rate]

F: taux d'erreur [rapport d'erreur]
S: tasa de errores [proporción de errores]

The ratio of the number of digital errors received in a specified period to the total number of digits received in the same period.

NOTES

- 1 Numerical values of error ratio should be expressed in the form

$$n \cdot 10^{-p}$$

where p is a positive integer.

- 2 Error ratio may be qualified, for example by the term "bit" or "block".

2032 error multiplication

F: multiplication d'erreurs
S: multiplicación de errores

The property of an apparatus whereby a single digital error in the input signal presented to it results in more than one digital error in the output signal.

NOTE – Line code converters and descramblers are examples of apparatus that may cause error multiplication.

2033 error multiplication factor

F: facteur de multiplication d'erreurs
S: factor de multiplicación de errores

The ratio of the number of digital errors in the output signal to the number of digital errors in the input signal.

NOTE – The error multiplication factor may be expressed as either an average or maximum value.

2034 error spread

F: étalement d'erreurs [répartition des erreurs]
S: dispersión de errores

The number of consecutive digits of the output signal over which digital errors are distributed when a single digital error in the input signal causes error multiplication.

2.3 Digital transmission**3001 digital transmission [107]**

F: transmission numérique
S: transmisión digital

The transmission of digital signals by means of a channel or channels that may assume in time any one of a defined set of discrete states.



3002 digital channel, digital transmission channel [109]*F: voie numérique, voie de transmission numérique**S: canal digital, canal de transmisión digital*

The means of unidirectional digital transmission of digital signals between two points.

3003 digital circuit, digital telecommunication circuit [112]*F: circuit numérique, circuit numérique de télécommunications**S: circuito digital, circuito de telecomunicación digital*

A combination of two digital transmission channels permitting bidirectional digital transmission in both directions between two points, to support a single communication.

NOTES

1 If the telecommunication is by nature unidirectional (for example, long-distance television transmission), the term "digital circuit" is sometimes used to designate the single digital channel providing the facility.

2 In a telecommunication network, use of the term "digital circuit" is generally limited to a digital telecommunication circuit directly connecting two switching devices or exchanges, together with associated terminating equipment.

3 A digital telecommunication circuit may permit transmission in both directions simultaneously (duplex), or not simultaneously (simplex).

4 A digital telecommunication circuit that is used for transmission in one direction only is sometimes referred to as a unidirectional digital telecommunication circuit. A digital telecommunication circuit that is used for transmission in both directions (whether simultaneously or not) is sometimes referred to as a bidirectional digital telecommunication circuit.

3004 digital connection [310]*F: connexion numérique**S: conexión digital*

A concatenation of digital transmission channels or digital telecommunication circuits, switching and other functional units set up to provide for the transfer of digital signals between two or more points in a telecommunication network, to support a single communication.

3005 digital link, digital transmission link [digital path] [302]*F: liaison numérique, liaison de transmission numérique [conduit numérique]**S: enlace digital, enlace de transmisión digital [trayecto digital]*

The whole of the means of digital transmission of a digital signal of specified rate between two digital distribution frames (or equivalent).

NOTES

1 A digital link comprises one or more digital sections and may include multiplexing and/or demultiplexing, but not switching.

2 The term may be qualified to indicate the transmission medium used, for example, "digital satellite link".

3 The term always applies to the combination of "go" and "return" directions of transmission, unless stated otherwise.

4 The term "digital path" is sometimes used to describe one or more digital links connected in tandem, especially between equipments at which the signals of the specified rate originate and terminate.

3006 digital distribution frame*F: répartiteur numérique**S: repartidor digital*

A structure that provides flexibility of semipermanent interconnection of digital channels or digital circuits.

NOTE – Digital sections and digital links normally terminate at digital distribution frames.

3007 digital section¹⁾*F: section numérique**S: sección digital*

The whole of the means of digital transmission of a digital signal of specified rate between two consecutive digital distribution frames or equivalent.

NOTES

1 A digital section forms either a part or the whole of a digital link, and includes terminating equipments at both ends, but excludes multiplexers.

2 Where appropriate, the digital rate or multiplex order should qualify the title.

3 The definition applies to the combination of "go" and "return" directions of transmission, unless stated otherwise.

3008 section termination*F: extrémité de section**S: extremo de sección*

A connectional interface selected to be the boundary between a physical transmission medium and its associated equipment.

NOTE – This point will usually be the connectors at the input and output of an equipment.

3009 elementary cable section [repeater section]*F: section élémentaire de câble [section (élémentaire) d'amplification]**S: sección elemental de cable [sección con amplificación]*

The whole of the physical transmission medium between the section termination at the output of one equipment and the section termination at the input of the following equipment.

NOTES

1 An elementary cable section usually consists of several factory lengths of cable connected together and any associated accessories (such as flexible cables) necessary to connect it to the section terminals.

2 Examples of the physical transmission media are a coaxial or symmetric pair, and optical fibre.

3010 elementary repeater section*F: section élémentaire amplifiée**S: sección elemental de repetición*

In a given direction of transmission, an elementary cable section together with the immediately following analogue repeater.

3011 elementary regenerator section [regenerator section]*F: section élémentaire régénérée [section de régénération]**S: sección elemental de regeneración [sección de regeneración]*

In a given direction of transmission, an elementary cable section together with the immediately following regenerative repeater.

3012 digital line section¹⁾*F: section de ligne numérique**S: sección de línea digital*

A digital section implemented on a single type of manufactured transmission medium, such as symmetric pair, coaxial pair, or optical fibre.

NOTE – A digital line section includes line terminating equipments at both ends, and regenerative repeaters if needed, but excludes multiplexers.

¹⁾ Figure 1 gives examples of digital sections, digital links, digital line sections, etc.