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Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 1-1: Definitions and terminology for synchronization networks

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Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 1-1: Definitions and terminology for synchronization networks

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Foreword

This European Standard (Telecommunications series) has been produced by the Transmission and Multiplexing (TM) Technical Committee.

The present document has been produced to provide requirements for synchronization networks that are compatible with the performance requirements of digital networks. It is one of a family of documents covering various aspects of synchronization networks:

Part 1-1:	**"Definitions and terminology for synchronization networks";**
Part 2-1:	"Synchronization network architecture";
Part 3-1:	"The control of jitter and wander within synchronization networks";
Part 4-1:	"Timing characteristics of slave clocks suitable for synchronization supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) equipment";
Part 4-2:	"Timing characteristics of slave clocks suitable for synchronization supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) equipment Implementation Conformance (ICS) Statement";
Part 5-1:	"Timing characteristics of slave clocks suitable for operation in Synchronous Digital Hierarchy (SDH) equipment";
Part 6-1:	"Timing characteristics of primary reference clocks";
Part 6-2:	"Timing characteristics of primary reference clocks Implementation Conformance (ICS) Statement";
Part 7-1:	"Timing characteristics of slave clocks suitable for synchronization supply to equipment in local node applications".

Parts 1-1, 2-1, 3-1 and 5-1 have previously been published as ETS 300 462 Parts 1, 2, 3 and 5, respectively.

Additionally, parts 4-1 and 6-1 completed the Voting phase of the Two Step Approval procedure as ETS 300 462 Parts 4 and 6, respectively.

It was decided to prepare ICS proformas for several of the parts and this necessitated a re-numbering of the individual document parts. It was also decided to create a new part 7-1.

This in turn led to a need to re-publish new versions of all six parts of the original ETS. At the same time, the opportunity was taken to convert the document type to EN.

This has involved no technical change to any of the documents. However part 5-1 has been modified, due to editorial errors which appeared in ETS 300 462-5.

Transposition dates	
Date of adoption:	4 April 1997
Date of latest announcement of this ETS (doa):	31 July 1997
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 January 1998
Date of withdrawal of any conflicting National Standard (dow):	31 January 1998

NOTE: The above transposition table is the original table from ETS 300 462-1 (April 1997, see History).

1 Scope

The present document specifies the definitions and abbreviations, used in the other parts of EN 300 462.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, subsequent revisions do apply.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ITU-R Recommendation 686 (1990): "Standard frequencies and time signals -Glossary".

[2] ETS 300 147 (1996): "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) Multiplexing Structure".

[3] EN 300 462-4-1: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 4-1: Timing characteristics of slave clocks suitable for synchronization supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) equipment".

[4] EN 300 462-5-1: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 5-1: Timing characteristics of slave clocks suitable for operation in Synchronous Digital Hierarchy (SDH) equipment".

[5] EN 300 462-6-1: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 6-1: Timing characteristics of primary reference clocks".

[6] ITU-T Recommendation G.701 (1993): "Vocabulary of digital transmission and multiplexing, and pulse code modulation (PCM) terms".

[7] ITU-T Recommendation G.704 (1995): "Synchronous frame structures used at 1 544, 6 312, 2 048, 8 488 and 44 736 kbit/s hierarchical levels".

[8] ITU-T Recommendation G.832 (1995): "Transport of SDH elements on PDH networks: Frame and multiplexing structures".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:

3.1.1 General definitions

bilateral: A synchronization link where the corrective action to maintain locking is active at both ends of the link.

jitter: Short term variations of the significant instants of a digital signal from their reference positions in time.

network synchronization: A generic concept that depicts the way of distributing a common time and/or frequency to all elements in a network.

single ended synchronization: A method of synchronizing a specified synchronization node with respect to another synchronization node in which synchronization information at the specified node is derived from the phase difference between the local clock and the incoming digital signal from the other node.

slip: The repetition or deletion of a block of bits in a synchronous or plesiochronous bit stream due to a discrepancy in the read and write rates at a buffer.

synchronization chain: An active interconnection of synchronization nodes and links.

synchronization reference chain: A specific synchronization chain defined in the present multi-part document to form the basis for simulations of jitter and wander in the synchronization network.

synchronization status message: A coding of the reference level of the timing source as specified in ETS 300 147 [2] for STM-N, ITU-T Recommendation G.704 [7] for 2 048 kbit/s, ITU-T Recommendation G.832 [8] for synchronous 34 Mbit/s and 140 Mbit/s.

time: Is used to specify an instant (time of the day) or as a measure of time interval.

NOTE 1: The words time or timing, when used to describe synchronization networks, usually refer to the frequency signals used for synchronization or measurement.

time scale: A system of unambiguous ordering of events.

NOTE 2: This could be a succession of equal time intervals, with accurate references of the limits of these time intervals, which follow each other without any interruption since a well defined origin. A time scale allows to date any event. For example, calendars are time scales. A frequency signal is not a time scale (every period is not marked and dated). For this reason "Universal Time Coordinated (UTC) frequency" should be used instead of "UTC".

unilateral: A synchronization link where the corrective action to maintain locking is only active at one end of the link.

Universal Time Coordinated (UTC): The time scale, maintained by the Bureau International des Poids et Mesures (BIPM) and the International Earth Rotation Service (IERS), which forms the basis of a coordinated dissemination of standard frequencies and time signal.

NOTE 3: The reference frequency for network synchronization is the frequency which generates the UTC time scale. It is therefore preferable to use the words "UTC frequency" instead of "UTC".

wander: The long term variations of the significant instances of a digital signal from their ideal positions in time (where long term implies that these variations are of frequencies less than 10 Hz).

NOTE 4: For the purposes of the present multi-part document, this definition of wander does not include integrated frequency departure.

3.1.2 Definitions related to clock equipments

clock: A device which provides a reference timing signal.

frequency standard: A generator, the output of which is used as a measurement reference timing signal.

local node: A synchronous network node which interfaces directly with customer equipment.

master clock: A clock providing a reference timing signal to other clocks, behaving as slave clocks.

node clock: Clock distributing synchronization reference timing signals within a node.

Primary Reference Clock (PRC): A reference clock that provides a reference timing signal compliant with EN 300 462-6-1 [5], in order to synchronize all or a large part of a network.

slave clock: A clock which is locked to a reference timing signal.

NOTE 1: When a slave clock loses all its reference timing signals and goes holdover, it can be considered as being a master clock under these conditions.

NOTE 2: In locked mode, the slave clock is synchronized to a reference timing signal. The output frequency of the clock is the same as the frequency of the reference timing signal over the long term, and the phase difference between the input and the output is bounded.

Stand Alone Synchronization Equipment (SASE): The stand alone implementation of the logical SSU function, which incorporates its own management function.

Synchronization Supply Unit (SSU): A logical function for reference timing signal selection, processing and distribution, having the frequency characteristics given in EN 300 462-4-1 [3].

transit node: A synchronous network node which interfaces with other nodes and does not directly interface with customer equipment.

3.1.3 Definitions related to synchronization networks

asynchronous mode: A mode where clocks are intended to operate in free running mode.

NOTE: This definition applies to clocks. However a more general definition applying to data network is in ITU-T Recommendation G.701 [6].

master slave mode: A mode where a designated master clock provides reference timing signals which are disseminated to all other clocks which are slaved to the master clock.

mutually synchronized mode: A mode where all clocks exert a degree of control of each other.

plesiochronous mode: A mode where the essential characteristic of time scales or signals such that their corresponding significant instants occur at nominally the same rate, any variation in rate being constrained within specified limits.

pseudo-synchronous mode: A mode where all clocks have a long term frequency accuracy compliant with a primary reference clock as specified in EN 300 462-6-1 [5] under normal operating conditions. Not all clocks in the network will have timing traceable to the same PRC.

synchronization link: A link between two synchronization nodes over which a reference timing signal is transmitted.

synchronization network: A network to provide reference timing signals. In general, the structure of a synchronization network comprises synchronization nodes connected by synchronization links.

synchronization trail: The logical representation of one or several synchronization links.

synchronous network: Where all clocks have the same long term accuracy under normal operating conditions.

3.1.4 Definitions related to clock modes of operation (applicable to slave clocks)

free running mode: An operating condition of a clock, the output signal of which is strongly influenced by the oscillating element and not controlled by servo phase-locking techniques. In this mode, the clock has never had a network reference input, or the clock has lost external reference and has no access to stored data, that could be acquired from a previously connected external reference. Free-run begins when the clock output no longer reflects the influence of a connected external reference, or transition from it. Free run terminates when the clock output has achieved lock to an external reference.

holdover mode: An operating condition of a clock which has lost its controlling input and is using stored data, acquired while in locked operation, to control its output. The stored data are used to control phase and frequency variations, allowing the locked condition to be reproduced within specifications. Holdover begins when the clock output no longer reflects the influence of a connected external reference, or transition from it. Holdover terminates when the output of the clock reverts to locked mode condition.

locked mode: An operating condition of a clock in which the output signal is controlled by an external input reference. It is the expected mode of operation of a slave clock and the state in which each clock within a chain of clocks has the same long term average frequency.

3.1.5 Definitions related to clock characterization

ageing: The systematic change in frequency of an oscillator with time.

NOTE 1: It is the frequency drift when factors external to the oscillator (environment, power supply, temperature, etc.) are kept constant. An ageing value should always be specified together with the corresponding duration.

fractional frequency deviation: The difference between the actual frequency of a signal and a specified nominal frequency, divided by the nominal frequency. Mathematically, the fractional frequency deviation y(t) can be expressed as:

$$y(t) = \frac{v(t) - v_{nom}}{v_{nom}}$$

frequency accuracy: The maximum magnitude of the fractional frequency deviation for a specified time period.

NOTE 2: The frequency accuracy includes the initial frequency offset and any ageing and environmental effect.

frequency drift: The systematic change in frequency of an oscillator caused by ageing and external effects (radiation, pressure, temperature, humidity, power supply, load, etc.).

NOTE 3: The external factors should always be clearly indicated.

frequency stability: The spontaneous and/or environmentally caused frequency change within a given time interval.

NOTE 4: It is generally distinguished between systematic effects such as frequency drift effects (caused by radiations, pressure, temperature, humidity, power supply, charge, ageing etc.) and stochastic frequency fluctuations which are typically characterized in time domain (special variances have been developed for the characterization of these fluctuations: Allan variance, modified Allan variance, Allan variance in time) and/or frequency domain (one sided spectral densities).

Maximum Relative Time Interval Error (MRTIE): The maximum peak-to-peak delay variation of an output timing signal with respect to a given input timing signal within an observation time ($\tau = n\tau_0$) for all observation times of that length within the measurement period (T).

Maximum Time Interval Error (MTIE): The maximum peak-to-peak delay variation of a given timing signal with respect to an ideal timing signal within an observation time ($\tau = n\tau_0$) for all observation times of that length within the measurement period (T). It is estimated using the following formula: