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Information technology — Telecommunications and information exchange between systems — Synchronization methods and technical requirements for Private Integrated Services Networks

Technologies de l'information — Télécommunications et échange d'information entre systèmes — Méthodes de synchronisation et exigences techniques pour les réseaux privés avec intégration de services

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Contents

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 11573 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology,* Subcommittee SC 6, *Telecommunications and information exchange between systems*.

During the preparation of this International Standard, information was gathered on patents upon which application of the standard might depend. Relevant patents were identified as belonging to ALCATEL Business Systems. However, ISO and IEC cannot give authoritative or comprehensive information about evidence, validity or scope of patent and like rights. The patent-holder has stated that licences will be granted under reasonable terms and conditions and communications on this subject should be addressed to

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Introduction

When synchronous digital signals are being transported over a communications link, the receiving end must operate at the same average frequency as the transmitting end to prevent loss of information. This is referred to as link synchronization. When digital signals traverse a network of digital communications links, switching nodes, multiplexers, and transmission interfaces, the task of keeping all the entities operating at the same average frequency is referred to as network synchronization.

The design of a PISN requires specification of the timing sources and receivers for the synchronization network. Proper design requires that timing loops in the synchronization network be avoided. A timing loop occurs when a clock is using as its reference frequency a signal that is itself traceable to the output of that clock. The formation of such a closed timing loop leads to frequency instability and is not permitted. While it is relatively straightforward to ensure against timing loops in the primary synchronization reference network, care should be taken that timing loops do not occur during failure or error conditions when various timing references are rearranged.

When a PISN is not connected to the public digital network, synchronization can be achieved by having all PISN equipment derive timing from a single source. This source should be the highest quality clock available. Alternatively, if timing is derived from more than one class I clock, or public clock traceable source, the network is said to be operating *plesiochronously*.

If a PISN is connected to the public network at one or more nodes, the private network designer can coordinate with the public network provider to derive class I clock, or public clock traceable timing from the public digital network. More information is available in Annex A.

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Section 1 : General

1.1 Scope

This International Standard contains requirements necessary for the synchronization of PISNs. Timing within a digital private network needs to be controlled carefully to ensure that the rate of occurrence of slips between PINXs within the PISN, and the public switched networks is sufficiently low not to affect unduly the performance of voice transmissions, or the accuracy or throughput (if errored data require re-transmission) of non-voice services.

Requirements are also based upon the interconnection of digital private telecommunication networks via digital facilities in the public (switched or not) telecommunication networks.

This International Standard is one of a series of technical standards on telecommunications networks. This International Standard with its companion standards fills a recognized need in the telecommunications industry brought about by the increasing use of digital equipment and facilities in private networks. It is useful to anyone engaged in the manufacture of digital customer premises equipment (CPE) for private network applications, and to those purchasing, operating or applying digital CPE to digital facilities for Private Integrated Services Networks (PISN).

This International Standard establishes technical criteria necessary in the design of a synchronization plan for a PISN. Compliance with these requirements would be expected to result in a quality PISN synchronization design.

1.2 Definitions

For the purposes of this International Standard, the following definitions apply:

1.2.1 Accuracy

A measure of the maximum departure from the nominal clock rate over a 24 h period, made anytime in the lifetime of the clock, during a defined period of time, within the declared environmental conditions. Frequency deviation may be constrained to the specific accuracy by clock operation in the free running or hold over modes, as defined below.

1.2.2 Asynchronous signals

Signals having not the same nominal rate.

1.2.3 Clock free running mode

In such a mode, the PINX works with its own clock source which is not locked to an external reference and is not using storage techniques to maintain its accuracy.

1.2.4 Clock hold over mode

An operating condition of a clock in which it is not locked to an external reference clock, but uses storage techniques to maintain during a limited period of time its accuracy with respects to the last known reference clock.

1.2.5 Controlled Slip

It consists of the repetition or deletion of an integer number of octets caused by the elastic buffer mechanism used at the interface of a non-synchronous bit stream (a plesiochronous or asynchronous one). Slips and controlled slips shall be considered synonymous in this International Standard.

1.2.6 Jitter

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

1.2.7 Lock range

Maximum frequency offset from the nominal, to which a given clock is able to synchronize.

1.2.8 Master

The term "master" refers to the clock source providing the timing to the PINX.

1.2.9 Maximum time interval error (MTIE)

The maximum time interval error (TIE) for all possible measurement intervals within the measurement period. Figure 1 illustrates the definition of MTIE.

1.2.10 Phase Locked Loop (PLL)

A feedback–controlled system that locks a local clock to an incoming reference clock in both frequency and phase.

1.2.11 Plesiochronous

The essential chracteristic of time–scales or signals such as their corresponding significant instants occur at nominally the same rate, any variation in rate being constrained within specified limits.

1.2.12 Primary Reference Clock

Equipment that provides a timing signal, with a long term accuracy equal or better than $\pm 10^{-11}$.

1.2.13 Pull in range

Maximum frequency offset from its own clock, to which a given clock is able to synchronize.

1.2.14 Reference Clock

Timing signal used for synchronization, without any assumption on its accuracy.

1.2.15 Slave

The term "slave" refers to the PINX receiving timing from another source.

1.2.16 Slip

Refer to controlled slip

1.2.17 Split Timing

An arrangement where equipment employs separate transmit and receive clocks on a transmission link having no particular relationship to one another.

1.2.18 Synchronous

Qualifies signals with corresponding significant instants occuring at the same mean rate; the time difference between these homologous instants is generally limited.

1.2.19 Synchronization

The process of adjusting the corresponding significant instants of signals so that a constant phase relationship exists between them.

1.2.20 Time–Interval Error (TIE)

The variation in time delay of a given timing signal with respect to an ideal timing signal over a particular time period. Figure 1 illustrates the definition of TIE.

1.2.21 Timing loop

An unstable condition in which two or more equipment clocks transfer timing to each other, forming a loop without a designated master timing source.

1.2.22 Time to repair

The time by which, with a stated probability, the link is repaired.

1.2.23 Transparent

A link or group of links is transparent if the signal carried is not re–timed from a clock associated with the link(s). The timing of a signal passing across a transparent link may however be altered due to jitter, wander, filtering, or fault conditions. Figure 2 illustrates the definition of transparent and non transparent links.

1.2.24 Wander

The long–term variations of the significant instants of a digital signal from their ideal positions in time. Long–term implies that these variations are of low frequency.