INTERNATIONAL TELECOMMUNICATION UNION

# ITU-T G.829

(03/2000)

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital transmission systems – Digital networks – Quality and availability targets

## Error performance events for SDH multiplex and regenerator sections

ITU-T Recommendation G.829

(Formerly CCITT Recommendation)

ITU-T G-SERIES RECOMMENDATIONS

**TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS**

| | |
|---|---|
| INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS | G.100–G.199 |
| GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS | G.200–G.299 |
| INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES | G.300–G.399 |
| GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES | G.400–G.449 |
| COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY | G.450–G.499 |
| TERMINAL EQUIPMENTS | G.700–G.799 |
| DIGITAL NETWORKS | G.800–G.899 |
| General aspects | G.800–G.809 |
| Design objectives for digital networks | G.810–G.819 |
| **Quality and availability targets** | **G.820–G.829** |
| Network capabilities and functions | G.830–G.839 |
| SDH network characteristics | G.840–G.849 |
| Management of transport network | G.850–G.859 |
| SDH radio and satellite systems integration | G.860–G.869 |
| Optical transport networks | G.870–G.879 |
| DIGITAL SECTIONS AND DIGITAL LINE SYSTEM | G.900–G.999 |

*For further details, please refer to the list of ITU-T Recommendations.*

**ITU-T Recommendation G.829**

# Error performance events for SDH multiplex and regenerator sections


## Summary

ITU-T Recommendation G.828 [6] specifies error performance parameters and objectives of international, constant bit rate synchronous digital paths. Error performance objectives of ITU-T Recommendation G.828 refer to the hypothetical reference path (HRP) of a length of 27 500 km. ITU-T Recommendation G.828 does not contain information on path elements.

NOTE – Performance objectives for SDH paths using equipment designed prior to the adoption of Recommendation G.828 in March 2000 are given in ITU-T Recommendation G.826. [5]

This ITU-T Recommendation defines error performance events and block structures for SDH multiplex and regenerator sections (see ITU-T Recommendations G.707 [1] and G.708 [2] for reference). SDH equipment functional blocks and SDH management are defined in ITU-T Recommendations G.783 [3] and G.784 [4]. Observing the definitions given in this Recommendation shall ensure that error performance assessment on SDH multiplex and regenerator sections yields compatible results. Definition of events in this ITU-T Recommendation is based on the same basic concept as in ITU-T Recommendation G.828 [6].

Performance monitoring of SDH sections is not mandatory. If implemented, the specifications of this ITU-T Recommendation apply



## Source

ITU-T Recommendation G.829 was prepared by ITU-T Study Group 13 (1997-2000) and approved under the WTSC Resolution 1 procedure on 10 March 2000.

## Keywords

Background Block Error, Block-based measurement concept, Error Detection Codes (EDC), Error performance events, Errored Second (ES), In-Service Measurements (ISM), SDH multiplex section, SDH regenerator section, SES Threshold, Severely Errored Second (SES), Synchronous Digital Hierarchy (SDH).

## FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. 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, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSC Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

## NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

## INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

## CONTENTS

**ITU-T Recommendation G.829**

# Error performance events for SDH multiplex and regenerator sections

## 1 Scope

This ITU-T Recommendation is applicable to multiplex and regenerator sections employing Synchronous Digital Hierarchy (SDH) technology. This ITU-T Recommendation is generic in that it defines the events for multiplex sections independent of the physical transport medium supporting the sections.

The performance events are applicable to each kind of multiplex section, based on optical fibre, digital radio relay, metallic cable and satellite transmission systems or on a combination of them.

The events defined for regenerator sections apply to microwave radio and satellite systems only.

In accordance with ITU-T Recommendation G.828 [6], the event definitions are block-based, making in-service error evaluation convenient.

Out-of-service measurements shall be based on the same principles.

This ITU-T Recommendation does not address error performance objectives and allocations. Performance limits for bringing-into-service and maintenance of international SDH multiplex and regenerator sections can be found in ITU-T Recommendation M.2101 [7].

This ITU-T Recommendation only specifies the unavailability of a single direction of a section, but not the unavailability of a section as such. This concept is different to the one used in ITU-T Recommendation G.828 [6] which contains a specification for the unavailability of a path taking into account both directions of that path (see Annex A).

## 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; all 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.

[1] ITU-T Recommendation G.707 (1996), *Network node interface for the Synchronous Digital Hierarchy.*

[2] ITU-T Recommendation G.708 (1999), *Sub STM-0 network node interface for the Synchronous Digital Hierarchy (SDH).*

[3] ITU-T Recommendation G.783 (1997), *Characteristics of Synchronous Digital Hierarchy equipment functional blocks.*

[4] ITU-T Recommendation G.784 (1999), *Synchronous digital hierarchy (SDH) management.*

[5] ITU-T Recommendation G.826 (1999), *Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate.*

[6] ITU-T Recommendation G.828 (2000), *Error performance parameters and objectives for international, constant bit rate synchronous digital paths.*

[7] ITU-T Recommendation M.2101 (2000), *Performance limits for bringing-into-service and maintenance of international SDH paths and multiplex sections.*

## 3 Abbreviations

This Recommendation uses the following abbreviations:

| | |
|---|---|
| AIS | Alarm Indication Signal |
| BBE | Background Block Error |
| BIP | Bit Interleaved Parity |
| EB | Errored Block |
| EDC | Error Detection Code |
| ES | Errored Second |
| HRP | Hypothetical Reference Path |
| ISM | In-Service Monitoring |
| LOF | Loss of Frame Alignment |
| LOS | Loss of Signal |
| OOS | Out-of-Service |
| RDI | Remote Defect Indication |
| REI | Remote Error Indication |
| RS-TIM | Regenerator Section Trace Identifier Mismatch |
| SDH | Synchronous Digital Hierarchy |
| SES | Severely Errored Second |
| STM | Synchronous Transport Module |

## 4 The definition and measurement of the block for SDH multiplex sections

### 4.1 Definition of the block for an SDH multiplex section

In accordance with ITU-T Recommendation G.828 [6], this ITU-T Recommendation is based upon the error performance measurement of blocks. This subclause gives definitions of the term "block" as follows:

**4.1.1 generic definition**: A block is a set of consecutive bits associated with the section; each bit belongs to one and only one block. "Consecutive" bits may not be contiguous in time.

**4.1.2 block definition applicable to Sub-STM-0 bit rates**: The 8 BIP-1s contained in the B2 byte of an SDH multiplex section in an sSTM-2n (n = 1, 2, 4) and sSTM-1k (k = 1, 2, 4, 8, 16) pertain to 8 different blocks. Thus, the signal structure of a generic multiplex section in an sSTM-2n and sSTM-1k comprises 8 blocks within a 125 µs frame.

The generic i-th block ($1 \leq i \leq 8$) is equivalent to the i-th bit of the B2 byte and the corresponding monitored bits in the same frame as defined in ITU-T Recommendation G.708 [2].

**4.1.3 block definition applicable to STM-0**: The 8 BIP-1s contained in the B2 byte of an SDH multiplex section in an STM-0 pertain to 8 different blocks. Thus, the signal structure of a generic multiplex section in an STM-0 comprises 8 blocks within a 125 µs frame.

The generic i-th block ($1 \leq i \leq 8$) is equivalent to the i-th bit of the B2 byte and the corresponding monitored bits in the same frame as defined in ITU-T Recommendation G.707 [1].

**4.1.4 block definition applicable to STM-N (N = 1, 4, 16, 64)**: The N × 24 BIP-1s contained in the B2 bytes of an SDH multiplex section in an STM-N (N = 1, 4, 16, 64) pertain to N × 24 different blocks. Thus, the signal structure of a generic multiplex section in an STM-N comprises N × 24 blocks within a 125 μs frame.

The generic i-th block ($1 \leq i \leq N \times 24$) is equivalent to the i-th bit of the B2 bytes and the corresponding monitored bits in the same frame as defined in ITU-T Recommendation G.707 [1].

## 4.2 Block sizes

Table 1 defines, for each type of multiplex section, the block size (number of bits per block), the number of blocks per second (blocks/s), the associated error detection code (EDC) and the blocks per frame.

**Table 1/G.829 – Block sizes, blocks per frame, blocks per second and EDCs for SDH multiplex sections**

| STM-N | Block Size | Blocks per Frame | Blocks per Second | EDC |
|---|---|---|---|---|
| sSTM-1k (Note 2) | k × 36 bits (Notes 2 and 4) | 8 | 64 000 (Note 5) | 8 × BIP-1 |
| sSTM-2n (Note 1) | n × 108 bits (Notes 1 and 3) | 8 | 64 000 (Note 5) | 8 × BIP-1 |
| STM-0 | 801 Bits | 8 | 64 000 (Note 5) | 8 × BIP-1 |
| STM-1 | 801 bits | 24 | 192 000 (Note 5) | 24 × BIP-1 |
| STM-4 | 801 bits | 96 | 768 000 (Note 5) | 96 × BIP-1 |
| STM-16 | 801 bits | 384 | 3 072 000 (Note 5) | 384 × BIP-1 |
| STM-64 | 801 bits | 1 536 | 12 288 000 (Note 5) | 1 536 × BIP-1 |

NOTE 1 – n = 1, 2 and 4 according to ITU-T Recommendation G.708 [2].

NOTE 2 – k = 1, 2, 4, 8, 16 according to ITU-T Recommendation G.708 [2].

NOTE 3 – Bits per frame composed by payload bytes 864 × n. The SOH bytes are excluded.

NOTE 4 – Bits per frame composed by payload bytes 288 × k. The SOH bytes are excluded.

NOTE 5 – Blocks per second = Blocks per frame × 8 000.

### 4.2.1 In-service monitoring of blocks

Each block is monitored by means of an inherent Error Detection Code, e.g. Bit Interleaved Parity. The EDC bits are physically separated from the block to which they apply. It is not normally possible to determine whether a block or its controlling EDC bits are in error. If there is a discrepancy between the EDC and its controlled block, it is always assumed that the controlled block is in error.

## 4.3 Out-of-service measurements of blocks

Out-of-service (OOS) measurements shall also be block-based and shall make use of the same blocks as defined for in-service monitoring (ISM). This will allow an easy comparison of OOS measurements and ISM. It is expected that the out-of-service error detection capability will be superior to the in-service capability described in 4.2.1.

## 5 Error performance events for SDH multiplex sections

### 5.1 Definitions

**5.1.1 errored block (EB)**: A block in which one or more bits are in error.

**5.1.2 errored second (ES)**: A one second period with one or more errored blocks or at least one defect (see Note 1).

**5.1.3 severely errored second (SES)**: A one-second period which contains ≥ X% errored blocks or at least one defect. SES is a subset of ES (see Notes 1 and 2).

NOTE 1 – The anomalies, defects and related performance criteria are listed in 5.2.1 and 5.2.2.

NOTE 2 – The threshold value of X% errored blocks has been chosen to improve consistency between SESs declared at the section and the path layer. It should be noted, however, that this consistency depends on the error distribution observed at the section under test and may also be influenced by the characteristics of the equipment under test (e.g. the modulation scheme used). Because of this dependency, full SES consistency at section and path layer cannot be expected. For maintenance purposes, consistency may be obtained, i.e. by applying media-dependent thresholds. The values of X for the various bit rates are given in Table 2.

**5.1.4 background block error (BBE)**: An errored block not occurring as part of an SES.

**Table 2/G.829 – SES thresholds for SDH multiplex sections**

| Bit rate | sSTM-21<br>sSTM-11 | sSTM-22<br>sSTM-12 | sSTM-24<br>sSTM-14 | sSTM-18 | sSTM-116 |
|---|---|---|---|---|---|
| **SES threshold X** | 10% EBs | 15% EBs | 25% EBs | 35% EBs | 40% EBs |

| Bit rate | STM-0 | STM-1 | STM-4 | STM-16 | STM-64 |
|---|---|---|---|---|---|
| **SES threshold X** | 15% EBs | 15% EBs | 25% EBs | 30% EBs | 30% EBs |

### 5.2 Events determination for multiplex sections

#### 5.2.1 Anomalies

In-service anomaly conditions are used in ITU-T Recommendations G.707 [1] and G.783 [3] to determine the error performance of an SDH section when the section is not in a defect state. The following anomalies are defined for a multiplex section:

$a_1$ An error as indicated by the EDC;

$a_2$ Multiplex section remote error indication (MS-REI).

#### 5.2.2 Defects

In-service defect conditions are used in ITU-T Recommendations G.707 [1] and G.783 [3] relevant to SDH equipment to determine the change of performance state which may occur on a section. The following categories of defects are defined for multiplex sections:

$d_1$ Multiplex section AIS (MS-AIS) (See Note);

$d_2$ Multiplex section remote defect indication (MS-RDI).

NOTE – This defect is an SDH multiplex section defect. Regenerator section defects such as LOS, LOF and RS-TIM give rise to an AIS defect in the multiplex section layer.

### 5.2.3 Estimation of the performance events

For SDH multiplex sections, the full set of performance events shall be estimated as follows:

ES: A near-end ES is observed when, during one second, at least one anomaly $a_1$, or one defect $d_1$ occurs.

A far-end ES is observed when, during one second, at least one anomaly $a_2$, or one defect $d_2$ occurs.

For the ES event, the actual count of EBs is irrelevant, it is only the fact that an EB has occurred in a second which is significant.

SES: A near-end SES is observed when, during one second, at least "Y" EBs – derived from anomaly $a_1$ or defect $d_1$ occur (see Note).

A far-end SES is observed when, during one second, at least "Y" EBs – derived from anomaly $a_2$ or defect $d_2$ occur (see Note).

BBE: A near-end BBE is observed when an anomaly $a_1$ occurs in a block not being part of an SES.

A far-end BBE is observed when an anomaly $a_2$ occurs in a block not being part of an SES.

NOTE – The value of "Y" is obtained by multiplying the number of blocks per second by X% (from the SES definition).

## 6 The definition and measurement of the block for SDH regenerator sections

Clauses 6 and 7 of this ITU-T Recommendation apply to radio-relay and satellite transmission systems.

**6.1 definition of the block for an SDH regenerator section**: In accordance with ITU-T Recommendation G.828 [6], this ITU-T Recommendation is based upon the error performance measurement of blocks. This subclause gives definitions of the term "block" as follows:

**6.1.1 generic definition**: A block is a set of consecutive bits associated with the section; each bit belongs to one and only one block. "Consecutive" bits may not be contiguous in time.

**6.1.2 block definition applicable to Sub-STM-0 bit rates**: The signal structure of a regenerator section sSTM-2n (n = 1, 2, 4) and sSTM-1k (k = 1, 2, 4, 8, 16) comprises 1 block within a 125 µs frame.

**6.1.3 block definition applicable to STM-0**: The BIP-8 contained in the B1 byte of an SDH regenerator section in an STM-0 pertains to 1 block. Thus, the signal structure of a regenerator section in an STM-0 comprises 1 block within a 125 µs frame.

The BIP-8 code and the corresponding monitored bits are defined in ITU-T Recommendation G.707 [1].

**6.1.4 block definition applicable to STM-N (N = 1, 4, 16)**: The N × BIP-8 contained in the B1 byte and in relevant media-dependent bytes of an SDH regenerator section in an STM-N ($N \geq 1$) pertains to N blocks. Thus, the signal structure of a regenerator section in an STM-N comprises N blocks within a 125 µs frame.

The i-th block ($1 \leq i \leq N$) is equivalent to the i-th BIP-8 byte and the corresponding monitored bits in the same frame.

### 6.2 Block sizes

Table 3 defines, for each type of regenerator section, the block size (number of bits per block), the number of blocks per second (blocks/s), the associated error detection code (EDC) and the blocks per frame.

**Table 3/G.829 – Block sizes, blocks per frame, blocks per second and EDCs for SDH regenerator sections**

| STM-N | Block Size | Blocks per Frame | Blocks/s | EDC (Note 3) |
|---|---|---|---|---|
| sSTM-2n (Note 1) | n × 864 bits | 1 | 8 000 | Media specific, to be defined |
| sSTM-1k (Note 2) | k × 288 Bits | 1 | 8 000 | Media specific, to be defined |
| STM-0 | 6 480 bits | 1 | 8 000 | BIP-8 |
| STM-1 | 19 440 bits | 1 | 8 000 | BIP-8 |
| STM-4 | 19 440 bits | 4 | 4 × 8 000 | 4 × BIP-8 |
| STM-16 | 19 440 bits | 16 | 16 × 8 000 | 16 × BIP-8 |
| NOTE 1 – n = 1, 2 and 4 according to ITU-T Recommendation G.708 [2].<br>NOTE 2 – k = 1, 2, 4, 8 and 16 according to ITU-T Recommendation G.708.<br>NOTE 3 – The EDC is a media specific indicator which is under study in other ITU Study Groups for media specific error performance purposes. (See 6.3 for more details). | | | | |

### 6.3 In-service monitoring of blocks

Each block is monitored by means of an inherent Error Detection Code, e.g. Bit Interleaved Parity. The EDC bits are physically separated from the block to which they apply. It is not normally possible to determine whether a block or its controlling EDC bits are in error. If there is a discrepancy between the EDC and its controlled block, it is always assumed that the controlled block is in error.

For Sub-STM-0 rates no specific EDC is given, since ITU-T Recommendation G.708 defines it for media specific application. In this generic definition, it is recommended that for in-service monitoring purposes the EDC capability be as such that the probability to detect an error event is ≥90% assuming Poisson error distribution. An example of an EDC which fulfils the monitoring requirements is the BIP-8 code.

### 6.4 Out-of-service measurements of blocks

On condition that a suitable interface is available, Out-of-Service (OOS) measurements shall also be block-based and shall make use of the same blocks as defined for in-service monitoring (ISM). This will allow an easy comparison of OOS measurements and ISM. It is expected that the out-of-service error detection capability will be superior to the in-service capability described in 6.3.

## 7 Error performance events for SDH regenerator sections

Clauses 6 and 7 of this ITU-T Recommendation apply to radio-relay and satellite transmission systems.

### 7.1 Definitions

**7.1.1 errored block (EB)**: A block in which one or more bits are in error.

**7.1.2 errored second (ES)**: A one second period with one or more errored blocks or at least one defect (see Note 1).

**7.1.3 severely errored second (SES)**: A one-second period which contains ≥X% errored blocks or at least one defect. SES is a subset of ES, where the value of X is defined in Table 4 (see Notes 1 and 2).

NOTE 1 – The anomalies, defects and related performance criteria are listed in 7.2.1 and 7.2.2.

NOTE 2 – The SES threshold for sSTM-2n (n = 1, 2, 4) and sSTM-1k (k = 1, 2, 4, 8, 16) rates are evaluated considering an EDC with a detection probability greater than 90%.

**7.1.4 background block error (BBE)**: An errored block not occurring as part of an SES.

**Table 4/G.829 – SES thresholds for SDH regenerator sections**

| Bit rate | sSTM-21<br>sSTM-11 | sSTM-22<br>sSTM-12 | sSTM-24<br>sSTM-14 | sSTM-18<br>sSTM-116 |
|---|---|---|---|---|
| **SES threshold X** | 10% EBs | 25% EBs | 45% EBs | 60% EBs |

| Bit rate | STM-0 | STM-1 | STM-4 | STM-16 |
|---|---|---|---|---|
| **SES threshold X** | 10% EBs | 30% EBs | 30% EBs | 30% EBs |

## 7.2 Events determination for regenerator sections

### 7.2.1 Anomalies

In-service anomaly conditions are used in ITU-T Recommendations G.707 [1] and G.783 [3] to determine the error performance of an SDH section when the section is not in a defect state. The following anomaly is defined for a regenerator section:

$a_1$ An error on the whole block as indicated by the EDC.

### 7.2.2 Defects

In-service defect conditions are used in ITU-T Recommendations G.707 [1] and G.783 [3] relevant to SDH equipment to determine the change of performance state which may occur on a section. The following categories of defects are defined for regenerator sections:

$d_1$ LOS;

$d_2$ LOF;

$d_3$ RS-TIM.

### 7.2.3 Estimation of the performance events

For SDH regenerator sections, the full set of near-end performance events shall be estimated as follows:

ES: A near-end ES is observed when, during one second, at least one anomaly $a_1$, or one defect $d_1$ occurs.

For the ES event, the actual count of EBs is irrelevant, it is only the fact that an EB has occurred in a second which is significant.

SES: A near-end SES is observed when, during one second, at least "Y" EBs – derived from anomaly $a_1$ or defect $d_1$ occur (see Note).

BBE: A near-end BBE is observed when an anomaly $a_1$ occurs in a block not being part of an SES.

NOTE – The value of "Y" is obtained by multiplying the number of blocks per second by X% (from the SES definition).

ANNEX A

## Entry and exit criteria for the unavailable state of a single direction of an SDH section

### A.1 Criteria for a Single Direction

A period of unavailable time begins at the onset of ten consecutive SES events. These ten seconds are considered to be part of unavailable time. A new period of available time begins at the onset of ten consecutive non-SES events. These ten seconds are considered to be part of available time. The availability criterion is defined for a single direction. To determine the entry to/exit from the unavailable state, the continuous collection of SESs is necessary.

Figure A.1 illustrates this definition.

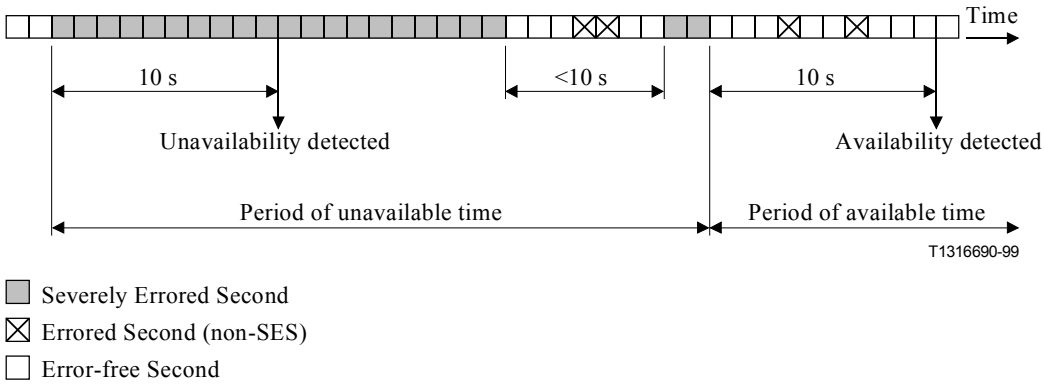


**Figure A.1/G.829 – Example of unavailability determination**

This ITU-T Recommendation only specifies the unavailability of a single direction of a section, but not the unavailability of a section as such. This concept is different to the one used in ITU-T Recommendation G.828 [6] which contains a specification for the unavailability of a path taking into account both directions of that path. (An obvious exception are unidirectional paths where unavailability is only related to the relevant direction.)

The reasons for using different concepts in both ITU-T Recommendations are as follows:

This ITU-T Recommendation deals with sections and is therefore not directly related to a service. It is network-oriented and treats each direction independently. ITU-T Recommendations G.826 and G.828, however, specify end-to-end error performance objectives for a path and thus are service-oriented. As most services are bidirectional, it follows that a path must be available in both directions to provide a meaningful service.

With regard to regenerator sections it should be noted that REI and RDI indications are not available at this level. Therefore, bidirectional monitoring of availability on a single signal is not possible and each direction has to be monitored separately.

## SERIES OF ITU-T RECOMMENDATIONS

| | |
|---|---|
| Series A | Organization of the work of ITU-T |
| Series B | Means of expression: definitions, symbols, classification |
| Series C | General telecommunication statistics |
| Series D | General tariff principles |
| Series E | Overall network operation, telephone service, service operation and human factors |
| Series F | Non-telephone telecommunication services |
| **Series G** | **Transmission systems and media, digital systems and networks** |
| Series H | Audiovisual and multimedia systems |
| Series I | Integrated services digital network |
| Series J | Transmission of television, sound programme and other multimedia signals |
| Series K | Protection against interference |
| Series L | Construction, installation and protection of cables and other elements of outside plant |
| Series M | TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits |
| Series N | Maintenance: international sound programme and television transmission circuits |
| Series O | Specifications of measuring equipment |
| Series P | Telephone transmission quality, telephone installations, local line networks |
| Series Q | Switching and signalling |
| Series R | Telegraph transmission |
| Series S | Telegraph services terminal equipment |
| Series T | Terminals for telematic services |
| Series U | Telegraph switching |
| Series V | Data communication over the telephone network |
| Series X | Data networks and open system communications |
| Series Y | Global information infrastructure and Internet protocol aspects |
| Series Z | Languages and general software aspects for telecommunication systems |

Geneva, 2001