INTERNATIONAL TELECOMMUNICATION UNION

ITU-T E.800

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(08/94)

TELEPHONE NETWORK AND ISDN

QUALITY OF SERVICE, NETWORK MANAGEMENT AND TRAFFIC ENGINEERING

TERMS AND DEFINITIONS RELATED TO QUALITY OF SERVICE AND NETWORK PERFORMANCE INCLUDING DEPENDABILITY

ITU-T Recommendation E.800

(Previously “CCITT Recommendation”)

FOREWORD

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

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation E.800 was revised by ITU-T Study Group 2 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 12th of August 1994.

NOTE

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

CONTENTS

			Page
1	Introduction		1
	1.1	Overview	1
	1.2	General guide to concepts	1
	1.3	General performance concepts	3
2	General terminology		3
	2.1	Service related performance	3
	2.2	Item related performance	4
	2.3	Common concepts	4
3	Quality of service terminology		5
	3.1	Service support	5
	3.2	Service operability	6
	3.3	Serveability	7
	3.4	Service security	10
4	Network performance terminology		10
	4.1	Trafficability	10
	4.2	Dependability	10
	4.3	Transmission	17
	4.4	Charging	18
5	Evaluation concepts		18
	5.1	Common concepts	18
	5.2	Measure modifiers	18
	5.3	Events and states	19
	5.4	Statistical concepts	27
	5.5	Maintenance concepts	32
	5.6	Time concepts	36
	5.7	Test, data, design and analysis concepts	41
Annex A – Related QoS/NP Handbooks and E-Series Recommendations			46
Annex B – Relations between defect, failure and fault concepts			48
Annex C – List of recommended symbols and abbreviations			49
Index – Alphabetical list of definitions contained in this Recommendation			50

Recommendation E.800

TERMS AND DEFINITIONS RELATED TO QUALITY OF SERVICE AND NETWORK PERFORMANCE INCLUDING DEPENDABILITY

(revised in 1994)

1 Introduction

1.1 Overview

Terminology standardization is necessary for two main reasons:

– to avoid confusion to standards users by introducing conflicting terms and definitions;

– to assist alignment between the various groups involved in telecommunication standards development.

A consistent set of terms and definitions is required, therefore, to develop the important areas of quality of service, network performance and dependability standards pertaining to the planning, provisioning and operation of telecommunication networks.

The intention of this Recommendation is to set out a comprehensive set of terms and definitions relating to these concepts. Associated terminology covering statistical terms, recommended modifiers etc. is also included to ensure the broadest possible coverage in one document. These collective terms and definitions can be universally applied to all telecommunication services and the network arrangements used to provide them.

The terms and definitions start at clause 2 and the general list can be found indexed in Annex D.

1.2 General guide to concepts

Figure 1 (Performance Concepts) is a framework intended to provide a general guide to the factors which contribute collectively to the overall quality of service as perceived by the user of a telecommunication service. The terms in the diagram can be thought of as generally applying either to the quality of service levels actually achieved in practice, to objectives which represent quality of service goals, or to requirements which reflect design specifications.

The figure is structured to show that one quality of service factor can depend on a number of others. It is important to note – although it is not explicitly stated in any of the definitions contained in this document – that the value of a characteristic measure of a particular factor may depend directly on corresponding values of other factors which contribute to it. This necessitates, whenever the value of a measure is given, that all of the conditions having an impact on that value be clearly stated.

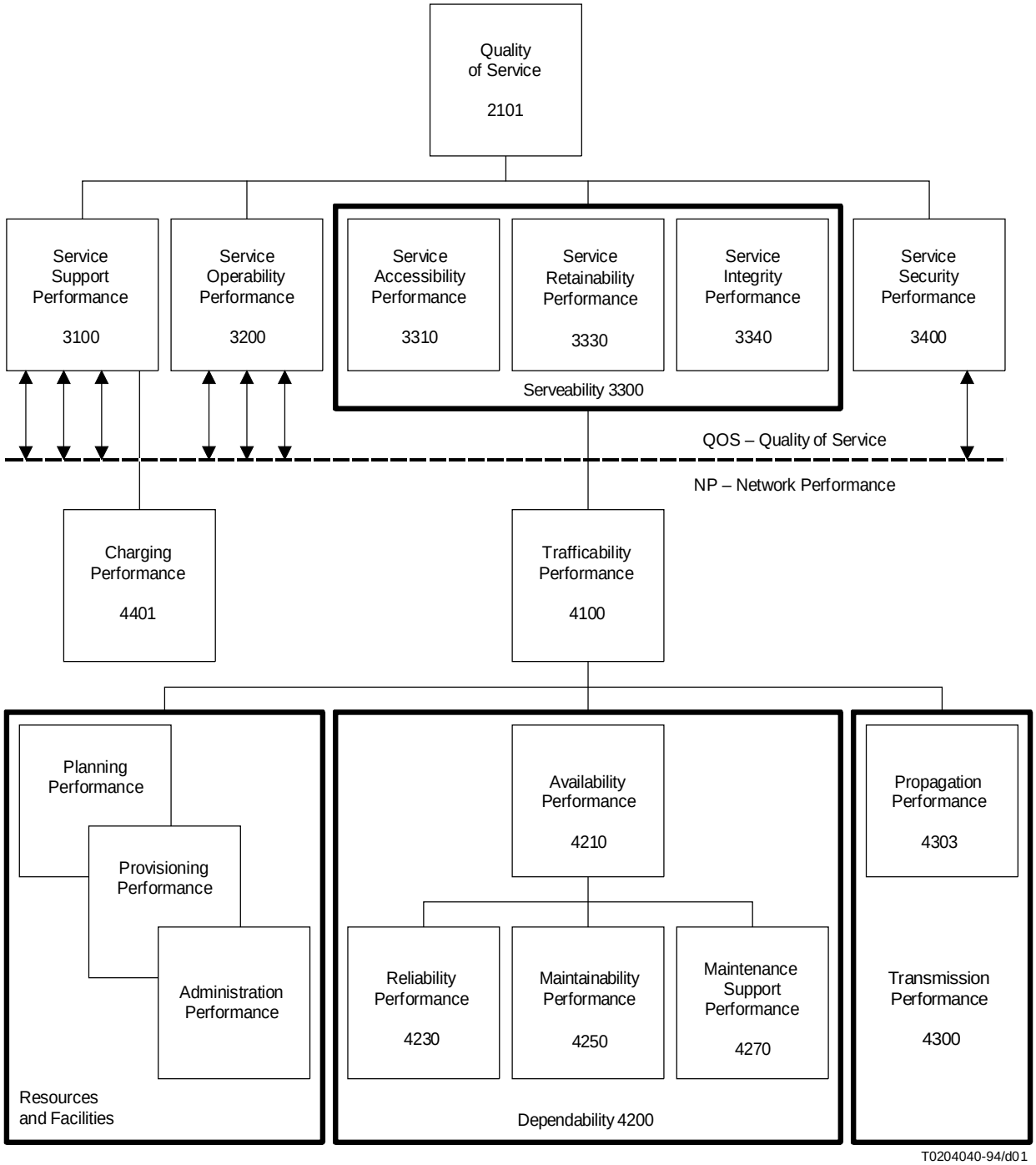
The essential aspect of the global evaluation of a service is the opinion of the users of the service. The result of this evaluation expresses the users' degrees of satisfaction. This Recommendation provides a framework for:

1) the quality of service concept;

2) relating quality of service and network performance;

3) a set of performance measures.

It is obvious that a service can be used only if it is provided, and it is desirable that the provider has a detailed knowledge about the quality of the offered service. From the provider's viewpoint, network performance is a concept by which network characteristics can be defined, measured and controlled to achieve a satisfactory level of service quality. It is up to the Service Provider to combine different network performance parameters in such a way that the economic requirements of the Service Provider as well as the satisfaction of the User are both fulfilled.



NOTES

1 Each concept may effect the one above collectively or individually.

2 For the sake of clarity not all relationships are indicated, though they may be implied on the figure.

FIGURE 1/E.800

Performance concepts

In the utilization of a service the User normally identifies the Service Provider only. The User's degree of satisfaction with the service provided depends on quality of service, that is on the latter's perception of the following service performance:

- the support;
- the operability;
- the serveability;
- the security.

All are dependent on network characteristics[1)]. However, the serveability performance is the most generally affected. It is further subdivided into three terms:

- service accessibility performance;
- service retainability performance;
- service integrity performance.

Serveability performance depends on trafficability performance and its influencing factors of resourcing and facility, dependability and transmission performance (of which propagation performance is a subset), as shown in Figure 1. The trafficability performance is described in terms of losses and delay times. Dependability is the combined aspects of availability, reliability, maintainability and maintenance support performance and relates to the ability of an item to be in a state to perform a required function. Propagation performance refers to the ability of the transmitting medium to transmit the signal within intended tolerances.

The resources and facilities box includes planning performance, provisioning performance and the related administrative functions. This spotlights the importance of the network planning and provisioning aspects, etc. to the overall quality of service results. These items are for further study.

1.3 General performance concepts

All performance concepts may be related to instant of time (instantaneous, etc.) or expressed as a mean value over a time interval.

While dependability is used only for a general description in non-quantitative terms, the actual quantification is done under the heading of availability performance, reliability performance, maintainability performance and maintenance support performance.

The properties expressed by these measures impact the measures relating to quality of service and network performance and are thus implicitly characterizations of these performance measures.

Measures are connected to events (failure, restoration, etc.), states (fault, up state, down state, outage, etc.) or activities (e.g. maintenance), with their time durations.

2 General terminology

2.1 Service related performance

2101 quality of service

F: qualité de service

S: calidad de servicio

The collective effect of service performance which determine the degree of satisfaction of a *user* of the *service*.

---

1) The service support performance may depend on certain aspects of the network performance, for example through the charging correctness performance.

NOTES

1 The *quality of service* is characterized by the combined aspects of *service support performance*, *service operability performance*, *serveability performance*, *service security performance* and other factors specific to each service.

2 The term "quality of service" is not used to express a degree of excellence in a comparative sense nor is it used in a quantitative sense for technical evaluations. In these cases a qualifying adjective (modifier) should be used.

2.2 Item related performance

2201 network performance

F: qualité de fonctionnement du réseau

S: calidad de funcionamiento de la red

The ability of a network or network portion to provide the functions related to *communications* between *users*.

NOTES

1 Network performance applies to the Network Provider's planning, development, operations and maintenance and is the detailed technical part of QOS, excluding service support performance and human factors.

2 Network performance is the main influence on serveability performance.

3 Network performance measures are meaningful to network providers and are quantifiable at the part of the network to which they apply. Quality of service measures are only quantifiable at a service access point.

4 It is up to the Network Provider to combine the Network Performance parameters in such a way that the economic requirements of the Network Provider, as well as the satisfaction of the User, are both fulfilled.

2.3 Common concepts

2301 service

F: service

S: servicio

A set of functions offered to a user by an organization.

2302 item; entity; element

F: entité; individu; élément

S: elemento; entidad; item

Any part, device, subsystem, functional unit, equipment or system that can be individually considered.

NOTES

1 An item may consist of hardware, software or both, and may also include people, e.g. operators in a telephone operator system.

2 In French, the term "entité" replaces the term dispostif previously used in this meaning, because the term dispositif is also the common equivalent for the English term "device".

3 In French, the term "individu" is used mainly in statistics.

2303 user

F: usager

S: usuario

Any entity external to the network which utilizes connections through the network for communication.

2304 connection

F: connexion

S: conexión

An association of resources providing means for communication between two or more devices in, or attached to, a telecommunication network.

2305 teletraffic; telecommunications traffic

F: télétrafic; trafic de télécommunication

S: teletráfico; tráfico de telecomunicaciones

A process of events related to demands for the utilization of resources in a telecommunication network.

2306 resource

F: ressource

S: órgano; recurso

Any set of physically or conceptually identifiable entities within a telecommunications network, the use of which can be unambiguously determined.

2307 capability

F: capacité; capabilité (d'une entité)

S: capacidad

The ability of an *item* to meet a demand of a given size under given internal conditions.

NOTES

1 Internal conditions refer, for example, to any given combination of *faulty* and not *faulty* sub-items.

2 Trafficability performance and effectiveness are capabilities.

3 Demands are of two types – service and traffic.

3 Quality of service terminology

3.1 Service support

3100 service support performance

F: logistique du service

S: logística del servicio

The ability of an organization to provide a *service* and assist in its utilization.

NOTE – An example of *service support performance* is the ability to provide assistance in commissioning a basic service, or a supplementary service such as the call waiting service or directory enquiries service.

For this performance concept the following measures will be used:

3101 mean service provisioning time

F: délai moyen pour la fourniture d'un service

S: tiempo medio de espera (para la prestación de un servicio)

The *expectation* of the *duration* between the *instant of time* a potential *user* requests that an organization provides the necessary means for a *service*, and the *instant of time* when these means are furnished.

3102 billing error probability

F: probabilité d'erreur de facturation

S: probabilidad de error de facturación

The *probability* of an *error* when billing a *user* of a *service*.

3103 incorrect charging or accounting probability

F: probabilité de taxation ou de comptabilisation erronées

S: probabilidad de tarificación o de contabilidad incorrectas

The *probability* of a *call attempt* receiving incorrect charging or accounting treatment.

3104 undercharging probability

F: probabilité de sous–taxation

S: probabilidad de subtarificación

The *probability* that a *call attempt* will be undercharged for any reason.

3105 overcharging probability

F: probabilité de surtaxation

S: probabilidad de sobretarificación

The *probability* that a *call attempt* will be overcharged for any reason.

3106 billing integrity (probability)

F: justesse de la facturation (probabilité de)

S: integridad de la facturación (probabilidad de)

The *probability* that the billing information presented to a *user* correctly reflects the type, destination and duration of the *call attempt*.

3.2 Service operability

3200 service operability performance

F: facilité d'utilisation d'un service

S: facilidad de utilización (de un servicio)

The ability of a *service* to be successfully and easily operated by a *user*.

For this performance concept the following measures will be used:

3201 service user mistake probability

F: probabilité d'erreur d'un usager en service

S: probabilidad de error de un usuario (de un servicio)

Probability of a *mistake* made by a *user* in his attempt to utilize a *service*.

3202 dialling mistake probability

F: probabilité d'erreur de numérotation

S: probabilidad de error de marcación

The *probability* that the *user* of a telecommunication network makes dialling *mistakes* during his *call attempts*.

3203 service user abandonment probability

F: probabilité d'abandon d'un service par un usager

S: probabilidad de abandono de un servicio por un usuario

The *probability* that a *user* abandons the attempt to use a *service*.

NOTE – Abandonments may be caused by excessive *user* mistake rates, by excessive service access delays, etc.

3204 call abandonment probability

F: probabilité d'abandon d'une tentative d'appel

S: probabilidad de abandono de un intento de llamada

The *probability* that a *user* abandons the *call attempt* through a telecommunication network.

3.3 Serveability

3300 serveability performance

F: servibilité d'un service

S: servibilidad del servicio

The ability of a *service* to be obtained – within specified tolerances and other given conditions – when requested by the *user* and continue to be provided without excessive impairment for a requested *duration*.

NOTE – Serveability performance may be subdivided into the service accessibility performance, service retainability performance and the service integrity performance.

3310 service accessibility performance

F: accessibilité d'un service

S: accesibilidad del servicio

The ability of a *service* to be obtained, within specified tolerances and other given conditions, when requested by the *user*.

NOTE – This takes into account the transmission tolerance and the combined aspects of *propagation performance*, *trafficability performance* and *availability performance* of the related systems.

For this performance concept the following measures will be used:

3311 service accessibility; service access probability

F: accessibilité d'un service; probabilité d'accès à un service

S: accesibilidad del servicio; probabilidad de acceso al servicio

The *probability* that a *service* can be obtained within specified tolerances and other given operating conditions when requested by the *user*.

3312 mean service access delay

F: durée moyenne d'accès à un service

S: retardo medio de acceso al servicio; demora media de acceso al servicio

The *expectation* of the *time duration* between an initial *bid* by the *user* for the acquisition of a *service* and the *instant of time* the user has access to the *service*, the *service* being obtained within specified tolerances and other given operating conditions.

3313 network accessibility

F: accessibilité d'un réseau

S: accesibilidad de la red

The *probability* that the *user* of a *service* after a request receives the proceed-to-select signal within specified conditions.

NOTE – The proceed-to-select signal is that signal inviting the *user* to select the desired *destination*.

3314 connection accessibility

F: accessibilité d'une connexion

S: accesibilidad de una conexión

The *probability* that a *connection* can be established within specified tolerances and other given conditions following receipt by the exchange of a valid code.

3315 mean access delay

F: durée moyenne d'accès

S: retardo medio de acceso; demora media de acceso

The *expectation* of the *time duration* between the first *call attempt* made by a *user* of a telecommunication network to reach another *user* or a *service* and the *instant of time* the *user* reaches the wanted other *user* or *service*, within specified tolerances and under given operational conditions.

3316 p-fractile access delay

F: quantile-p de la durée d'accès

S: cuantil-p del retardo de acceso; cuantil-p de la demora de acceso

The *p-fractile* value of the *duration* between the *first call attempt* made by a *user* of a telecommunication network to reach another *user* or a *service* and the *instant of time* the *user* reaches the wanted other *user* or *service*, within specified tolerances and under given operational conditions.

3317 accessibility of a connection to be established

F: accessibilité d'une communication à établir

S: accesibilidad de una conexión a establecer

The *probability* that a switched *connection* can be established, within specified transmission tolerances, to the correct *destination*, within a given *time interval*, when requested by the *user*.

NOTES

1 For user–originated calls, it could express the *probability* of a successful call establishment on the first attempt. For operator-handled calls, it could represent the *probability* of having a satisfactory *connection* established within a given *time duration*.

2 In general, the tolerances should correspond to a level of *transmission performance* which makes the connection unsatisfactory for *service* such that, for example, a substantial percentage of *users* would abandon the *connection*.

3318 unacceptable transmission probability

F: probabilité d'une transmission inacceptable

S: probabilidad de transmisión inaceptable

The *probability* of a *connection* being established with an unacceptable speech path transmission quality.

3319 no tone probability

F: probabilité d'absence de la tonalité

S: probabilidad de ausencia de tono

The *probability* of a *call attempt* encountering no tone following receipt of a valid code by the exchange.

3320 misrouting probability

F: probabilité d'acheminement erroné

S: probabilidad de encaminamiento erróneo

The *probability* of a *call attempt* being misrouted following receipt by the exchange of a valid code.

3330 service retainability performance

F: continuabilité d'un service

S: retenibilidad del servicio

The ability of a *service*, once obtained, to continue to be provided under given conditions for a requested duration.

NOTE – Generally this depends on the transmission tolerances, the *propagation performance* and *reliability performance* of the related systems. For some services, for example packet switching, this also depends on the *trafficability performance* and the *availability performance* of the related systems.

For this performance concept the following measures will be used:

3331 service retainability

F: continuabilité d'un service

S: retenibilidad del servicio

The *probability* that a *service*, once obtained, will continue to be provided under given conditions for a given *time duration*.

3332 connection retainability

F: continuabilité d'une connexion

S: retenibilidad de la conexión

The *probability* that a *connection*, once obtained, will continue to be provided for a *communication* under given conditions for a given *time duration*.

3333 retainability of an established connection

F: continuabilité d'une connexion établie

S: retenibilidad de la conexión establecida

The *probability* that a switched *connection*, once established, will operate within specified transmission tolerances without *interruption* for a given *time interval.*

3334 premature release probability; cut-off call probability

F: probabilité de libération prématurée; probabilité de commune d'une communication

S: probabilidad de liberación prematura; probabilidad de corte de la llamada

The *probability* that an established *connection* will be released for a reason other than intentionally by any of the parties involved in the call.

3335 release failure probability

F: probabilité d'échec de la libération

S: probabilidad de fallo de liberación

The *probability* that the required *release* of a *connection* will not take place.

3336 probability of successful service completion

F: probabilité d'exécution correcte d'un service

S: probabilidad de prestación satisfactoria de un servicio

The *probability* that a *connection* can be established, under satisfactory operating conditions, and retained for a given *time interval*.

3340 service integrity performance

F: integrité d'un service

S: integridad del servicio

The degree to which a *service* is provided without excessive impairments, once obtained.

For this performance concept the following measures will be used:

3341 interruption; break (of service)

F: interruption; coupure (d'un service)

S: interrupción; corte (del servicio)

Temporary inability of a *service* to be provided persisting for more than a given *time duration*, characterized by a change beyond given limits in at least one parameter essential for the *service*.

NOTES

1 An *interruption* of a *service* may be caused by *disabled states* of the *items* used for the *service* or by external reasons such as high service demand.

2 An *interruption* of a *service* is generally an *interruption* of the transmission, which may be characterized by an abnormal value of power level, noise level, signal distortion, *error* rate, etc.

3342 time between interruptions

F: temps entre interruptions

S: tiempo entre interrupciones

The *time duration* between the end of one *interruption* and the beginning of the next.

3343 interruption duration

F: durée d'interruption

S: duración de interrupción

The *time duration* of an *interruption*.

3344 mean time between interruptions (MTBI)

F: durée moyenne entre interruptions (MTBI)

S: tiempo medio entre interrupciones (MTBI)

The *expectation* of the *time between interruptions*.

3345 mean interruption duration (MID)

F: durée moyenne d'une interruption (MID)

S: duración media de una interrupción (MID)

The *expectation* of the *interruption duration*.

3.4 Service security

3400 service security performance

F: Securité d'un service

S: Seguridad del servicio

The protection provided against unauthorized monitoring, fraudulent use, malicious impairment, misuse, human mistake and natural disaster.

For this performance concept the following measures will be used:

(For further study.)

4 Network performance terminology

4.1 Trafficability

4100 trafficability performance

F: traficabilité; capacité d'écoulement du trafic

S: aptitud para cursar tráfico

The ability of an item to meet a traffic demand of a given size and other characteristics, under given internal conditions.

NOTE – Given internal conditions refer, for example, to any combination of faulty and not faulty sub-items.

For this performance concept the following measures will be used:

(For further study – see Recommendation E.600.)

4.2 Dependability

4200 dependability

F: sûreté de fonctionnement

S: seguridad de funcionamiento

The collective term used to describe the *availability performance* and its influencing factors: *reliability performance, maintainability performance* and *maintenance support performance*.

NOTE – *Dependability* is used only for general descriptions in non-quantitative terms.

4210 availability performance

F: disponibilité

S: disponibilidad

The ability of an *item* to be in a state to perform a *required function* at a given *instant of time* or at any *instant of time* within a given *time interval*, assuming that the external resources, if required, are provided.

NOTES

1 This ability depends on the combined aspects of the *reliability performance*, the *maintainability performance* and the *maintenance support performance* of an *item*.

2 In the definition of the *item* the external resources required must be delineated.

3 The term *availability* is used as an *availability performance measure*.

4 Warning: the term *availability* has occasionally been used in connection with the term *item*, but with an implied meaning of *item* being entirely different from that of this Recommendation.

For this performance concept the following measures will be used:

4211 instantaneous availability; pointwise availability; A(t) (symbol)

F: disponibilité (instantanée), A(t) (symbole)

S: disponibilidad instantánea, A(t) (símbolo)

The *probability* that an *item* is in an *up state* at a given *instant of time*, *t*.

NOTE – In French the term *disponibilité* is also used to denote the performance quantified by this *probability*.

4212 instantaneous unavailability; pointwise unavailability; U(t) (symbol)

F: indisponibilité instantanée, U(t) (symbole)

S: indisponibilidad instantánea, U(t) (símbolo)

The probability that an *item* is in a *down state* at a given *instant of time*, *t*.

4213 mean availability, $\bar{A}(t_1, t_2)$ (symbol)

F: disponibilité moyenne, $\bar{A}(t_1, t_2)$ (symbole)

S: disponibilidad media, $\bar{A}(t_1, t_2)$ (símbolo)

The normalized integral of the *instantaneous availability* in a given *time interval* (t_1, t_2).

NOTE – The *mean availability* is related to the *instantaneous availability* as

$$\bar{A}(t_1, t_2) = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} A(t)\, \mathrm{d}t$$

4214 mean unavailability, $\bar{U}(t_1, t_2)$ (symbol)

F: indisponibilité moyenne, $\bar{U}(t_1, t_2)$ (symbole)

S: indisponibilidad media, $\bar{U}(t_1, t_2)$ (símbolo)

The normalized integral of the *instantaneous unavailability* in a stated *time interval* (t_1, t_2).

NOTE – The *mean unavailability* is related to the *instantaneous unavailability* as

$$\bar{U}(t_1; t_2) = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} U(t)\, \mathrm{d}t$$

4215 (asymptotic) availability; (steady-state) availability, A (symbol)

F: disponibilité asymptotique, A (symbole)

S: disponibilidad (asintótica); disponibilidad (en régimen permanente); A (símbolo)

The limit, if this exists, of the *instantaneous availability* when the time tends to infinity.

NOTE – Under certain conditions, for instance constant failure rate and constant repair rate, the *asymptotic availability* may be expressed as:

$$A = \frac{MUT}{MUT + MDT}$$

where

MDT is the *mean down time*

MUT is the *mean up time.*

4216 asymptotic unavailability, U (symbol)

F: indisponibilité asymptotique, U (symbole)

S: indisponibilidad asintótica, U (símbolo)

The limit, if this exists, of the *instantaneous unavailability* when the time tends to infinity.

NOTE – Under certain conditions, for instance constant failure rate and constant repair rate, the *asymptotic unavailability* may be expressed as:

$$U = \frac{MDT}{MDT + MUT}$$

where

MDT is the *mean down time*

MUT is the *mean up time.*

4217 asymptotic mean availability, $\overline{A}$ (symbol)

F: disponibilité moyenne asymptotique, asymptotic mean availability, $\overline{A}$ (symbol) *(symbole)*

S: disponibilidad media asintótica, asymptotic mean availability, $\overline{A}$ (symbol) *(símbolo)*

The limit, if this exists, of the *mean availability* over a *time interval* (t_1, t_2) when t_2 tends to infinity.

NOTES

1 The *asymptotic mean availability* is related to the *mean availability* as

$$\overline{A} = \lim_{t_2 \to \infty} \overline{A}(t_1, t_2)$$

2 When such a limit exists it is not dependent on t_1.

4218 asymptotic mean unavailability, $\overline{U}$ (symbol)

F: indisponibilité moyenne asymptotique, $\overline{U}$ (symbole)

S: indisponibilidad media asintótica, $\overline{U}$ (símbolo)

The limit, if this exists, of the *mean unavailability* over a *time interval* (t_1, t_2) when t_2 tends to infinity.

NOTES

1 The *asymptotic mean unavailability* is related to the *mean unavailability* as

$$\overline{U} = \lim_{t_2 \to \infty} \overline{U}(t_1, t_2)$$

2 When such a limit exists it is not dependent on t_1.

4219 mean up time (MUT)

F: temps moyen de disponibilité; durée moyenne de disponibilité (MUT)

S: tiempo medio de disponibilidad (MUT)

The *expectation* of the *up time*.

4220 mean accumulated down time (MADT)

F: durée cumulée moyenne d'indisponibilité (MADT)

S: tiempo medio acumulado de indisponibilidad (MADT)

The *expectation* of the *accumulated down time*.

4221 instantaneous availability of a leased circuit

F: disponibilité instantanée d'un circuit loué

S: disponibilidad instantánea de un circuito arrendado

The *probability* that, under stated operating conditions, a leased circuit can perform a *required function* when requested by the subscriber.

4230 reliability performance

F: fiabilité

S: fiabilidad

The ability of an *item* to perform a *required function* under given conditions for a given *time interval*.

NOTES

1 It is generally assumed that the *item* is in a state to perform this *required function* at the beginning of the *time interval*.

2 The term reliability is used as a measure of reliability performance.

For this performance concept the following measures will be used:

4231 reliability, R (symbol)

F: fiabilité, R (symbole)

S: fiabilidad, R (símbolo)

The *probability* that an *item* can perform a *required function* under stated conditions for a given *time interval*.

NOTES

1 It is generally assumed that the *item* is in a state to perform this *required function* at the beginning of the *time interval*.

2 In French, the term *fiabilité* is also used to denote the performance quantified by this *probability*.

4232 (instantaneous) failure rate, $\lambda(t)$ (symbol)

F: taux (instantané) de défaillance, $\lambda(t)$ (symbole)

S: tasa (instantánea) de fallos, $\lambda(t)$ (símbolo)

The limit, if this exists, of the ratio of the conditional *probability* that the *time to failure*, *T*, of an *item* falls within a given *time interval*, $(t, t+\Delta t)$, to the length of this interval, Δt, when Δt tends to zero, given that the *item* is in a state to perform a *required function* at the beginning of the *time interval*.

NOTE – The *instantaneous failure rate* is expressed by formula as:

$$\lambda(t) = \lim_{\Delta(t)\to 0+} \frac{Pr\,(t < T \leq t + \Delta t \mid T > t)}{\Delta t}$$

where *T* is the instant of time of failure.

The formula is also applicable if *T* denotes the *time to failure*.

4233 mean failure rate, $\bar{\lambda}(t_1, t_2)$ (symbol)

F: taux moyen de défaillance $\bar{\lambda}(t_1, t_2)$ (symbole)

S: tasa media de fallos, $\bar{\lambda}(t_1, t_2)$ (símbolo)

The normalized integral of the *instantaneous failure rate* over a given *time interval*, (t_1, t_2).

NOTE – The *mean failure rate* relates to *instantaneous failure rate* as

$$\bar{\lambda}(t_1; t_2) = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} \lambda(t)\, dt$$

4234 (instantaneous) failure intensity, z(t) (symbol)

F: intensité (instantanée) de défaillance, z(t) (symbole)

S: intensitad (instantánea) de fallos, z(t) (símbolo)

The limit, if this exists, of the ratio of the mean number of *failures* of a *repaired item* in a *time interval*, $(t, t + \Delta t)$, to the length of this interval, Δt, when the length of the *time interval* tends to zero.

NOTE – The *instantaneous failure intensity* is expressed by formula as:

$$z(t) = \lim_{\Delta(t) \to 0+} \frac{E\left[N(t + \Delta t) - N(t)\right]}{\Delta t}$$

where $N(t)$ is the number of *failures* in the *time interval* $(0, t)$.

4235 mean failure intensity, $\bar{z}(t_1, t_2)$ (symbol)

F: intensité moyenne de défaillance, $\bar{z}(t_1, t_2)$(symbole)

S: intensidad media de fallos$\bar{z}(t_1, t_2)$ (símbolo)

The normalized integral of the *instantaneous failure intensity* over a given *time interval* (t_1, t_2).

NOTE – The *mean failure intensity* is related to *instantaneous failure intensity* as:

$$\bar{z}(t_1; t_2) = \frac{1}{t_1 - t_2} \int_{t_2}^{t_1} z(t)\, dt$$

4236 mean time to first failure (MTTFF)

F: durée moyenne de fonctionnement avant la première défaillance (MTTFF)

S: tiempo medio hasta el primer fallo (MTTFF)

The *expectation* of the *time to first failure*.

4237 mean time to failure (MTTF)

F: durée moyenne de fonctionnement avant défaillance (MTTF)

S: tiempo medio hasta el fallo (MTTF)

The *expectation* of the *time to failure*.

4238 mean time between failures (MTBF)

F: moyenne des temps entre défaillances (MTBF)

S: tiempo medio entre fallos (MTBF)

The *expectation* of the *time between failures*.

4239 failure rate acceleration factor

F: facteur d'accélération du taux de défaillance

S: factor de aceleración de la tasa de fallos

The ratio of the accelerated testing *failure rate* to the *failure rate* under stated reference test conditions.

NOTE – Both *failure rates* refer to the same time period in the life of the tested *items*.

4240 failure intensity acceleration factor

F: facteur d'accélération de l'intensité de défaillance

S: factor de aceleración de la intensidad de fallos

In a *time interval* of given *duration*, whose beginning is specified by a fixed age of a *repaired item*, the ratio of the number of *failures* obtained under two different sets of stress conditions.

4250 maintainability performance

F: maintenabilité

S: mantenibilidad

The ability of an *item* under stated conditions of use, to be retained in, or restored to, a state in which it can perform a *required function*, when *maintenance* is performed under given conditions and using stated procedures and resources.

NOTE – The term maintainability is used as a measure of maintainability performance.

For this performance concept the following measures will be used:

4251 maintainability

F: maintenabilité

S: mantenibilidad

The *probability* that a given active *maintenance action*, for an *item* under given conditions of use can be carried out within a stated *time interval*, when the *maintenance* is performed under stated conditions and using stated procedures and resources.

NOTE – In French the term *maintenabilité* is also to denote the performance quantified by this *probability*.

4252 (instantaneous) repair rate, μ(t) (symbol)

F: taux (instantané), de réparation, μ (t) (symbole)

S: tasa (instantánea) de reparaciones, μ (t) (símbolo)

The limit, if this exists, of the ratio of the conditional *probability* that the corrective *maintenance action* terminates in a *time interval*, $(t, t+\Delta t)$ to the length of this *time interval*, when Δt tends to zero, given that the action had not terminated at the beginning of the *time interval*.

NOTE – The *instantaneous repair rate* is expressed by formula as:

$$\mu(t) = \lim_{\Delta(t)\to 0+} \frac{Pr\,(t < T\ t + \Delta t \mid T > t)}{\Delta t}$$

where T is the instant of time of restoration.

T may also represent the *time to restoration*.

4253 mean repair rate, $\bar{\mu}(t_1, t_2)$ (symbol)

F: taux moyen de réparation, $\bar{\mu}(t_1, t_2)$ (symbole)

S: tasa media de reparaciones, $\bar{\mu}(t_1, t_2)$ (símbolo)

The normalized integral of the *instantaneous repair rate* over a given *time interval* (t_1, t_2).

NOTE – The *mean repair rate* is related to *instantaneous repair rate* as:

$$\bar{\mu}(t_1; t_2) = \frac{1}{t_1 - t_2} \int_{t_2}^{t_1} \mu(t)\, dt$$

4254 mean maintenance man-hours

F: durée moyenne équivalente de maintenance

S: duración media equivalente de mantenimiento; media de horas-hombre de mantenimiento

The *expectation* of the *maintenance man-hours*.

4255 mean down time (MDT)

F: temps moyen d'indisponibilité; durée moyenne d'indisponibilité (MDT)

S: tiempo medio de indisponibilidad (MDT)

The *expectation* of the *down time*.

4256 mean repair time (MRT)

F: durée moyenne de réparation (MRT)

S: tiempo medio de reparación (MRT)

The *expectation* of the *repair time*.

4257 p-fractile repair time

F: quantile-p de la durée de réparation

S: cuantil-p del tiempo de reparación

The *p-fractile* value of the *repair time*.

4258 mean active repair time (MART)

F: durée moyenne de réparation active (MART)

S: tiempo medio de reparación activa (MART)

The *expectation* of the *active repair time*.

4259 p-fractile active repair time

F: quantile-p de la durée de réparation active

S: cuantil-p del tiempo de reparación activa

The *p-fractile* value of the *active repair time*.

4260 mean time to restoration (MTTR); mean time to recovery; mean time to repair (deprecated)

F: durée moyenne de panne (MTTR)

S: tiempo medio hasta el restablecimiento (MTTR)

The *expectation* of the *time to restoration*.

4261 fault coverage

F: couverture des pannes

S: cobertura de averías

The proportion of *faults* of an *item* that can be recognized under given conditions.

4262 repair coverage

F: couverture des réparations

S: cobertura de reparaciones

The proportion of *faults* of an *item* that can be successfully removed.

4270 maintenance support performance

F: logistique de maintenance

S: logística de mantenimiento

The ability of a maintenance organization, under given conditions, to provide upon demand the resources required to maintain an *item*, under a given *maintenance policy*.

NOTE – The given conditions are related to the *item* itself and to the conditions under which the *item* is used and maintained.

For this performance concept the following measures will be used:

4271 mean administrative delay (MAD)

F: durée moyenne du délai administratif (MAD)

S: retardo medio administrativo; demora media administrativa (MAD)

The *expectation* of the *administrative delay*.

4272 p-fractile administrative delay

F: quantile-p du délai administratif

S: cuantil-p del retardo administrativo; cuantil–p de la demora administrativa

The *p-fractile* value of the *administrative delay*.

4273 mean logistic delay (MLD)

F: durée moyenne du délai logistique (MLD)

S: retardo medio logístico; demora media logística (MLD)

The *expectation* of the *logistic delay*.

4274 p-fractile logistic delay

F: quantile-p du délai logistique

S: cuantil-p del retardo logístico; cuantil-p de la demora logística

The *p-fractile* value of the *logistic delay*.

4.3 Transmission

4300 transmission performance

F: qualité de transmission

S: calidad de transmisión

The level of reproduction of a signal offered to a telecommunications system, under given conditions, when this system is in an *up state*.

NOTE – The given conditions may include the effect of propagation performance where applicable.

For this performance concept the following measures are applicable. (This section is for further study.)

4301 bit error ratio (BER)

F: taux d'erreur sur les bits (BER)

S: tasa de errores de bit; tasa de error en los bits (BER)

The ratio of the number of bit errors to the total number of bits transmitted in a given *time interval*.

4302 error free seconds ratio

F: taux de secondes sans erreur

S: segundos sin error

The ratio of the number of one-second intervals during which no bits are received in error to the total number of one-second intervals in the *time interval*.

NOTES

1 The length of the *time interval* needs to be specified.

2 This ratio is usually expressed as a percentage.

4303 propagation performance

F: caractéristiques de propagation

S: característica de propagación

The ability of a propagation medium, in which a wave propagates without artificial guide, to transmit a signal within the given tolerances.

NOTES

1 The given tolerances may apply to variations in signal level, noise, interference levels, etc.

2 Propagation performance applies to radiocommunication only.

4.4 Charging

4401 charging correctness

F: exactitude de la taxation

S: probabilidad de tarificación correcta; precisión de la tasación

The probability that the network correctly charges the communication by type, destination, time location and duration.

5 Evaluation concepts

5.1 Common concepts

5101 effectiveness (performance)

F: efficacité

S: efectividad

The ability of an *item* to meet a service demand of a given size.

NOTE – This ability depends on the combined aspects of the *capability* and the *availability performance* of the *item*.

5102 durability

F: durabilité

S: durabilidad

The ability of an *item* to remain in a condition where it can perform a *required function* under stated conditions of use and *maintenance* until a limiting state is reached.

NOTE – A limiting state of an *item* may be characterized by the end of the *useful life*, unsuitability for any economic or technological reasons, etc.

5103 modification (of an item)

F: modification (d'une entité)

S: modificación (de un elemento)

The combination of all technical and corresponding administrative actions intended to alter the *capability* of an *item* by changing, adding or deleting one or more *required functions*.

5.2 Measure modifiers

5201 true ...

F: ... vrai

S: ... verdadero

The ideal value which characterizes a quantity perfectly defined under the conditions which exist at the moment when that quantity is observed, or the subject of a determination.

NOTE – This value could be arrived at only if all causes of measurement *error* were eliminated.

5202 predicted ...

F: ... prédit; ... prévu

S: ... previsto; ... predicho

The numerical value assigned to a quantity, before the quantity is actually observable, computed on the basis of earlier observed or estimated values of the same quantity or of other quantities using a mathematical model.

5203 extrapolated ...

F: ... extrapolé

S: ... extrapolado

The *predicted* value based on *estimated* values for one or a set of conditions, intended to apply to other conditions such as time, *maintenance* and environmental conditions.

5204 estimated ...

F: ... estimé

S: ... estimado

The value obtained as the result of an *estimation*.

NOTE – The result may be expressed either as a single numerical value, a point estimate, or as a *confidence interval*.

5205 intrinsic ...; inherent ...

F: ... intrinsèque; ... inhérent

S: ... intrínseco; ... inherente

Value of a *measure* determined when maintenance and operational conditions are assumed to be ideal.

5206 operational ...

F: ... opérationnel

S: ... operacional

Value determined under given operational conditions.

5207 mean ...; average ... (deprecated)

F: ... moyen (adjectif)

S: ... medio (adjetivo); promedio (desaconsejado)

1) The value obtained as the *expectation* of a *random variable*.

2) The normalized integral of a time dependant quantity.

5208 p-fractile ...

F: ... quantile-p

S: cuantil-p de ...

The value obtained as the *p-fractile* of the distribution of a *random variable*.

5209 instantaneous ...

F: ... instantané

S: ... instantáneo

The value of a *measure* determined for a given *instant of time*.

5.3 Events and states

5.3.1 Defects

5301 defect

F: défaut

S: defecto

Any departure of a characteristic of an *item* from requirements.

NOTES

1 The requirements may or may not be expressed in the form of a specification.

2 A defect may or may not affect the ability of an *item* to perform a *required function*.

5302 bug

F: erreur de programmation; bogue

S: error de programación

A software *defect* caused by a *mistake*.

5303 critical defect

F: défaut critique

S: defecto crítico

A *defect* that is assessed likely to result in injury to persons or significant material damage.

5304 non-critical defect

F: défaut non critique

S: defecto no crítico

A *defect* other than a *critical defect.*

5305 major defect

F: défaut majeur

S: defecto mayor

A *defect* that is likely to result in a *failure* or to reduce materially the usability of the *item* for its intended purpose.

5306 minor defect; imperfection

F: défaut mineur; imperfection

S: defecto menor; imperfección

A defect other than a *major defect*.

5307 defective; defective item

F: défectueux; entité défectueuse

S: defectuoso; elemento defectuoso

An *item* which contains one or more *defects*.

5308 critical defective item

F: défectueux critique

S: elemento defectuoso crítico

An *item* which contains one or more *critical defect.*

5309 major defective item

F: défectueux majeur

S: elemento defectuoso mayor

An *item* which contains one or more *major defects*.

5310 minor defective item

F: défectueux mineur

S: elemento defectuoso menor

An *item* which contains one or more *minor defects* but no *major defects*.

5311 design defect

F: défaut de conception

S: defecto de diseño

A *defect* due to an inadequate design of an *item*.

5312 manufacturing defect

F: défaut de fabrication

S: defecto de fabricación

A *defect* due to non conformance in manufacture to the design of an *item* or to specified manufacturing processes.

5.3.2 Failures

5321 failure

F: défaillance

S: fallo

The termination of the ability of an *item* to perform a *required function*.

NOTE – After *failure* the *item* has a fault.

5322 critical failure

F: défaillance critique

S: fallo crítico

A *failure* which is assessed likely to result in injury to persons or significant material damage.

5323 non-critical failure

F: défaillance non critique

S: fallo no crítico

A *failure* other than a *critical failure*.

5324 misuse failure

F: défaillance par mauvaise utilisation

S: fallo por uso incorrecto

A *failure* due to induced stresses during use which are beyond the stated capabilities of the *item*.

5325 mishandling failure

F: défaillance par fausse manoeuvre

S: fallo por manejo incorrecto

A *failure* caused by incorrect handling or lack of care of the *item*.

5326 (inherent) weakness failure

F: défaillance par fragilité (inhérente)

S: fallo por fragilidad (inherente)

A *failure* due to a weakness inherent in the *item* itself when subjected to stresses within the stated capabilities of the *item*.

5327 design failure

F: défaillance de conception

S: fallo de diseño

A *failure* due to a *design defect*.

5328 manufacturing failure

F: défaillance de fabrication

S: fallo de fabricación

A *failure* due to a *manufacturing defect*.

5329 ageing failure; wearout failure

F: défaillance par vieillissement; défaillance par usure

S: fallo por envejecimiento; fallo por desgaste

A *failure* whose probability of occurrence increases with the passage of time, as a result of processes inherent in the *item*.

5330 sudden failure

F: défaillance soudaine

S: fallo repentino

A *failure* that could not be anticipated by prior examination or monitoring.

5331 gradual failure; degradation failure; drift failure

F: défaillance progressive; dégradation; défaillance par dérive

S: fallo gradual; fallo por degradación; fallo por deriva

A *failure* due to a gradual change in time of given characteristics of an *item* and that could be anticipated by prior examination or monitoring.

NOTE – A gradual failure can sometimes be avoided by preventive maintenance.

5332 cataleptic failure; catastrophic failure (deprecated)

F: défaillance cataleptique

S: fallo cataléptico; fallo catastrófico (desaconsejado)

A *sudden failure* which results in a *complete fault*.

5333 relevant failure

F: défaillance pertinente; défaillance à prendre en compte

S: fallo pertinente; fallo relevante

A *failure* to be included in interpreting test or operational results or in calculating the value of a *reliability performance measure*.

NOTE – The criteria for the inclusion should be stated.

5334 non-relevant failure

F: défaillance non pertinente; défaillance à ne pas prendre en compte

S: fallo no pertinente; fallo irrelevante

A *failure* to be excluded in interpreting test or operational results or in calculating the value of a *reliability performance measure*.

NOTE – The criteria for the exclusion should be stated.

5335 primary failure

F: défaillance primaire

S: fallo primario

A *failure* of an *item*, not caused either directly or indirectly by the *failure* or the *fault* of another *item*.

5336 secondary failure

F: défaillance secondaire

S: fallo secundario

A *failure* of an *item*, caused either directly or indirectly by the *failure* or the *fault* of another *item*.

5337 failure cause

F: cause de défaillance

S: causa de fallo

The circumstances during design, manufacture or use which have led to a *failure*.

5338 failure mechanism

F: mécanisme de défaillance

S: mecanismo de fallo

The physical, chemical or other process which has led to a *failure*.

5339 systematic failure; reproducible failure; deterministic failure

F: défaillance systématique; défaillance reproductible

S: fallo sistemático; fallo reproducible; fallo determinístico

A *failure* related in a deterministic way to a certain cause, which can only be eliminated by a *modification* of the design or manufacturing process, operational procedures, documentation or other relevant factors.

NOTES

1 Corrective *maintenance* without *modification* will usually not eliminate the *failure cause*.

2 A *systematic failure* can be induced at will by simulating the *failure cause*.

5.3.3 Faults

5341 fault

F: panne; dérangement

S: avería

The inability of an *item* to perform a *required function*, excluding that inability due to *preventive maintenance*, lack of external resources or planned actions.

NOTE – A *fault* is often the result of a *failure* of the *item* itself, but may exist without prior *failure*.

5342 critical fault

F: panne critique

S: avería crítica

A *fault* which is assessed likely to result in injury to persons or significant damage to material.

5343 non-critical fault

F: panne non critique

S: avería no crítica

A *fault*, other than a *critical fault*.

5344 major fault

F: panne majeure

S: avería mayor

A *fault* which affects a function considered to be of major importance.

5345 minor fault

F: panne mineure

S: avería menor

A *fault* other than a *major fault*.

5346 misuse fault

F: panne par mauvaise utilisation

S: avería por uso incorrecto

A *fault* due to induced stresses during use which are beyond the stated capabilities of the *item*.

5347 mishandling fault

F: panne par fausse manoeuvre

S: avería por manejo incorrecto

A *fault* caused by incorrect handling or lack of care of the *item.*

5348 (inherent) weakness fault

F: panne par fragilité (inhérente)

S: avería por fragilidad (inherente)

A *fault* due to a weakness inherent in the *item* itself when subjected to stresses within the stated capabilities of the *item*.

5349 design fault

F: panne de conception

S: avería de diseño

A *fault* due to a *design defect*.

5350 manufacturing fault

F: panne de fabrication

S: avería de fabricación

A *fault* due to a *manufacturing defect*.

5351 ageing fault; wearout fault

F: panne par vieillissement; panne par usure

S: avería por envejecimiento; avería por desgaste

A *fault* resulting from an *ageing failure*.

5352 programme-sensitive fault

F: panne dépendante du programme

S: avería dependiente del programa

A fault that is revealed as a result of the execution of some particular sequence of instructions

5353 data-sensitive fault

F: panne dépendante des données

S: avería dependiente de los datos

A *fault* that is revealed as a result of the processing of a particular pattern of data.

5354 complete fault; function preventing fault

F: panne complète

S: avería completa

A *fault* characterized by complete inability to perform all *required functions* of an *item*.

NOTE – The criteria for a *complete fault* have to be stated.

5355 partial fault

F: panne partielle

S: avería parcial

A *fault* of an *item* other than a *complete fault*.

5356 persistent fault; permanent fault; solid fault

F: panne permanente

S: avería permanente

A *fault* of an *item* that persists until an action of *corrective maintenance* is performed.

5357 intermittent fault; volatile fault; transient fault

F: panne intermittente; panne temporaire

S: avería intermitente; avería transitoria

A fault of an *item* which persists for a limited *time duration* following which the *item* recovers the ability to perform a *required function* without being subjected to any action of *corrective maintenance*.

NOTE – Such a *fault* is often recurrent.

5358 determinate fault

F: panne franche

S: avería clara; avería determinable

For an *item*, which produces a response as a result of an action, a *fault* for which the response is the same for all actions.

5359 indeterminate fault

F: panne indéterminée

S: avería indeterminable

For an *item*, which produces a response as a result of an action, a *fault* such that the *error* affecting the response depends on the action applied.

NOTE – An example would be a *data-sensitive fault*.

5360 latent fault

F: panne latente

S: avería latente

An existing *fault* that has not yet been recognized.

5361 systematic fault

F: panne systématique

S: avería sistemática

A *fault* resulting from a *systematic failure*.

5362 fault mode; failure mode (deprecated)

F: mode de panne; mode de défaillance (terme déconseillé)

S: modo de avería; modo de fallo (desaconsejado)

One of the possible states of a *faulty item*, for a given *required function*.

5363 faulty

F: en panne

S: averiado

Property of having a *fault*.

5.3.4 Errors and mistakes

5371 error

F: erreur

S: error

A discrepancy between a computed, observed or measured value or condition and the true, specified or theoretically correct value or condition.

NOTE – An *error* can be caused by a *faulty item*, e.g. a computing *error* made by a *faulty* computer equipment.

5372 execution error; generated error

F: erreur d'exécution

S: error de ejecución

Error produced during the operation of a *faulty item*.

5373 interaction error (man-machine)

F: erreur d'interaction (homme-machine)

S: error de interacción (hombre-máquina)

An *error* in the response of an *item* caused by a *mistake* during its use.

5374 propagated error

F: erreur propagée

S: error propagado

An *error* in the response to erroneous data input to a non-faulty *item.*

5375 mistake; error (deprecated in this sense)

F: erreur (humaine); faute

S: equivocación; error (desaconsejado en este sentido)

A human action that produces an unintended result.

5.3.5 Item related states

(See also Figure 2.)

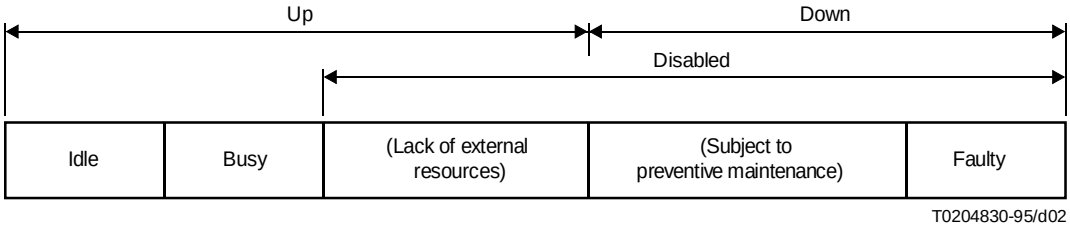


FIGURE 2/E.800

Classification of item states

5381 operating state

F: état de fonctionnement

S: estado de funcionamiento; estado operacional

The state when an *item* is performing a *required function*.

5382 non-operating state

F: état de non-fonctionnement

S: estado de no funcionamiento

The state when an *item* is not performing a *required function*.

5383 standby state

F: état d'attente; en réserve

S: estado de espera (en reserva)

A non-operating *up state* during the *required time*.

5384 idle state; free state

F: état libre; état vacant

S: estado de reposo; estado libre

A non-operating *up state* during *non-required time*.

5385 disabled state; outage

F: état d'incapicité

S: estado de incapacidad

A state of an *item* characterized by its inability to perform a *required function*, for any reason.

5386 external disabled state

F: état d'incapacité externe

S: estado de incapacidad externa

That subset of the *disabled state* when the *item* is in an *up state*, but lacks required external resources.

5387 down state; internal disabled state

F: état d'indisponibilité; état d'incapacité interne

S: estado de indisponibilidad; estado de incapacidad interna

A state of an *item* characterized by a *fault* or by a possible inability to perform a *required function* during *preventive maintenance*.

NOTE – This state relates to *availability performance*.

5388 up state

F: état de disponibilité

S: estado de disponibilidad

A state of an *item* characterized by the fact that it can perform a *required function*, assuming that the external resources, if required, are provided.

NOTE – This state relates to *availability performance*.

5389 busy state

F: état occupé; occupation

S: estado de ocupación; estado de ocupado

The state of an *item* in which it performs a *required function* for a user and for that reason is not accessible by other users.

5390 critical state

F: état critique

S: estado crítico

A state of an *item* assessed likely to result in injury to persons or significant material damage.

NOTE – A *critical state* may be the result of a *critical fault*, but not necessarily.

5.4 Statistical concepts

The quantitative applications of measures for quality of service, network performance, dependability and trafficability performance require a fundamental set of statistical concepts.

This subclause provides the terms and definitions for such applications

5401 characteristic

F: caractère (statistique)

S: característica

A property which helps to differentiate between the individuals of a given population.

NOTE – The differentiation may be either quantitative (by variables) or qualitative (by attributes).

5402 probability

F: probabilité

S: probabilidad

For practical reasons, it may be considered that, whenever the conditions of a *test* can be reproduced, the *probability Pr(E)* of an event *E* occurring is the value around which the occurrence frequency of the latter oscillates and towards which it tends when the number of tests are indefinitely increased.

NOTE – The concept of *probability* may be introduced in either of two forms, depending on whether it is intended to designate a degree of belief or whether it is considered as the limit value of a frequency. In both cases, its introduction requires that some precautions be taken which cannot be developed within the context of an International Standard and for which users should refer to specialized literature.

5403 random variable; variate

F: variable aléatoire

S: variable aleatoria

A variable which may take any of the values of a specified set of values and with which is associated a probability distribution.

NOTE – A *random variable* which may take only isolated values is said to be "discrete". A *random variable* which may take all the values of a finite or infinite interval is said to be "continuous".

5404 random process

F: processus aléatoire; processus stochastique

S: proceso aleatorio; proceso estocástico

A collection of time-dependent *random variables* where the values are governed by a given set of multivariate distributions for all combinations of the *random variables*.

5405 distribution function

F: fonction de répartition

S: función de distribución

A function giving, for every value *x*, the *probability* that the *random variable X* is less than or equal to *x*:

$$F(x) = Pr(X \leq x)$$

5406 probability density function

F: densité de probabilité

S: función densidad de probabilidad

The derivative, if this exists, of the *distribution function*:

$$f(x) = \frac{dF(x)}{dx}$$

5407 p-fractile; p-quantile (of a probability distribution)

F: quantile d'ordre p; quantile-p (d'une loi de probabilité)

S: cuantil-p; cuantil de orden p (de una ley de distribución de probabilidades)

If *p* is a number between 0 and 1, the *p–fractile* is the value of the *random variable* for which the *distribution function* equals *p* or "jumps" from a value less than or equal to *p* to a value greater than *p*.

NOTE – It is possible that the distribution function equals p throughout the interval between consecutive possible values of the variate. In this case, any value in this interval may be considered as the p-fractile.

5408 expectation (of a random variable); mean (of a random variable)

F: espérance mathématique (d'une variable aléatoire); moyenne (d'une variable aléatoire)

S: esperanza matemática (de una variable aleatoria); media (de una variable aleatoria)

a) For a discrete *random variable X* taking the values x_i with the *probabilites* p_i,

$$E(X) = \sum p_i x_i$$

the sum being extended over all the values x_i which can be taken by X.

b) For a continuous *random variable X* having the probability density function $f(x)$,

$$E(X) = \int x\, f(x)\, \mathrm{d}x$$

the integral being extended over all values of the interval of variation of X.

NOTES

1 No distinction is made between the *expectation* of a *random variable* and that of a *probability* distribution.

2 The term *mean* is also used with other meanings, for example as the normalized integral over a *time interval*.

5409 variance (of a random variable)

F: variance (d'une variable aléatoire)

S: varianza (de una variable aleatoria)

The *expectation* of the square of the difference between a *random variable* and the *expectation* of this variable.

5410 standard deviation, δ (symbol)

F: écart–type, δ (symbole)

S: desviación típica, δ (símbolo)

The positive square root of the *variance*.

5411 observed value (in statistics)

F: valeur observée (en statistique)

S: valor observado (en estadística)

The value of a *characteristic* determined as the result of an observation or *test*.

5412 relative frequency

F: fréquence (statistique)

S: frecuencia relativa

The ratio of the number of times a particular value, or a value falling within a given class, is observed to the total number of observations.

5413 statistical test

F: test statistique

S: prueba estadística

A procedure that is intended to decide whether a hypothesis about the distribution of one or more populations should be rejected or not rejected (accepted).

NOTES

1 The decision taken is a result of the value of an appropriate *statistic* or *statistics*, calculated from values observed in samples taken from the populations under consideration. As the value of the *statistic* is subject to random variations, there is some risk of *error* when the decision is taken.

2 It is important to note that, generally speaking, a *test* assumes *a priori* that certain assumptions are fulfilled (for example, assumption of independence of the observations, assumption of normality, etc.). These assumptions serve as a basis of the *test*.

5414 one-sided test

F: test unilatéral

S: prueba unilateral

A *statistical test* in which the *statistic* used is one-dimensional and the *critical region* is the set of values lower than, or the set of values greater than, a given number.

5415 two-sided test

F: test bilatéral

S: prueba bilateral

A *statistical test* in which the *statistic* used is one–dimensional and in which the *critical region* is the set of values lower than a first given number and the set of values greater than a second given number.

5416 null hypothesis, H_0 (symbol)

F: hypothèse nulle, H_0 (symbole)

S: hipótesis nula, H_0 (símbolo)

The hypothesis to be rejected or not rejected (accepted) at the outcome of the *statistical test.*

5417 alternative hypothesis, H_1 (symbol)

F: hypothèse alternative, H_1 (symbole)

S: hipótesis alternativa, H_1 (símbolo)

The hypothesis, usually composite, which is opposed to the *null hypothesis*.

5418 critical region

F: région critique

S: región crítica

The set of possible values of the *statistic* used such that, if the value of the *statistic* which results from the *observed values* belongs to the set, the *null hypothesis* will be rejected, whereas it will not be rejected (accepted) if the opposite is the case.

5419 critical values

F: valeurs critiques

S: valores críticos

The given value(s) which limit the *critical region.*

5420 error of the first kind

F: erreur de première espèce

S: error de primera clase

The *error* committed in rejecting the *null hypothesis*, because the *statistic* takes a value which belongs to the *critical region*, when the *null hypothesis* is true.

5421 type I risk

F: risque de première espèce

S: riesgo de tipo I

The *probability* of committing the *error of the first kind*, which varies according to the real situation (within the framework of the *null hypothesis*). Its maximum value is the *significance level* of the *statistical test.*

5422 error of the second kind

F: erreur de seconde espèce

S: error de segunda clase

The *error* committed in failing to reject (accept) the *null hypothesis* (because the value of the *statistic* does not belong to the *critical region*), when the *null hypothesis* is not true (the *alternative hypothesis* therefore being true).

5423 type II risk

F: risque de seconde espèce

S: riesgo de tipo II

The *probability*, designated β, of committing the *error of the second kind*. Its value depends on the real situation and can only be calculated if the *alternative hypothesis* is adequately specified.

5424 operating characteristic curve; OC curve (for a statistical test plan)

F: courbe d'efficacité (d'un plan de test)

S: curva característica de funcionamiento (para un plan de prueba estadística)

A curve showing, for a given *statistical test* plan, the *probability of acceptance* as a function of the actual value of a given *measure*.

5425 producer's risk (point)

F: (point du) risque du fournisseur

S: (punto de) riesgo del proveedor

A point on the *operating characteristic curve* corresponding to some predetermined and usually low *probability of rejection*.

5426 consumer's risk (point)

F: (point du) risque du client

S: (punto de) riesgo del consumidor

A point on the *operating characteristic curve* corresponding to a predetermined and usually low *probability of acceptance*.

5427 power of the test

F: puissance du test

S: potencia de la prueba

The *probability* of not committing the *error of the second kind*, equal to 1 – α, and thus the *probability* of rejecting the *null hypothesis* when this hypothesis is false.

5428 significance level (of a statistical test), α (symbol)

F: niveau de signification (d'un test statistique); seuil de signification, α (symbole)

S: nivel de significación (de una prueba estadística); umbral de significación, α (símbolo)

The given value which limits the *probability* of the *null hypothesis* being rejected, if the *null hypothesis* is true.

NOTE – The *critical region* is determined in such a way that if the *null hypothesis* is true, the *probability* of this *null hypothesis* being rejected should be not more than this given value.

5429 probability of acceptance

F: probabilité d'acceptation

S: probabilidad de aceptación

The *probability* that an *item* will be accepted by a given *statistical test* plan.

5430 probability of rejection

F: probabilité de rejet

S: probabilidad de rechazo

The *probability* that an *item* will not be accepted by a given *statistical test* plan.

5431 confidence interval

F: intervalle de confiance

S: intervalo de confianza

The random interval limited by two *statistics* or by a single *statistic*, such that the *probability* that a parameter to be estimated is covered by this interval is equal to a given value.

5432 statistical tolerance interval

F: intervalle statistique de dispersion

S: intervalo estadístico de tolerancia

A random interval limited by two *statistics* or by a single *statistic*, such that the *probability* that a fraction of the population, equal to or greater than a given value between 0 and 1, is covered by this interval is equal to a given value $1 - \alpha$, where α is the *significance level*.

5433 confidence limit

F: limite de confiance

S: límite de confianza

Each of the limits of a two-sided *confidence interval*, or the single limit of a one-sided *confidence interval*.

5434 estimation

F: estimation (de paramètres)

S: estimación (de parámetros)

The operation made for the purpose of assigning, from the observed values in a sample, numerical values to the parameters of the distribution chosen as the statistical model of the population from which this sample is taken.

5435 estimate

F: estimation

S: estimación

The result of an *estimation*.

NOTE – This result may be expressed either as a single numerical value (point estimation) or as a *confidence interval*.

5436 estimator

F: estimateur

S: estimador

A *statistic* intended to estimate a population parameter.

5437 confidence coefficient; confidence level

F: niveau de confiance

S: coeficiente de confianza; nivel de confianza

The value of the *probability* associated with a *confidence interval* or a *statistical tolerance interval*.

5438 statistic

F: statistique

S: estadístico

A function of the *observed values* derived from a sample.

5439 acceptable level (of a measure)

F: niveau acceptable (d'une caractéristique)

S: nivel aceptable (de una medida)

A level for a *measure* of a given performance which in a *test* plan corresponds to a specified but relatively high *probability of acceptance*.

5.5 Maintenance concepts

5501 maintenance philosophy

F: philosophie de maintenance

S: filosofía de mantenimiento

A system of underlying principles for the organization and execution of the *maintenance*.

5502 maintenance policy

F: politique de maintenance

S: política de mantenimiento

A description of the interrelationship between the *maintenance echelons*, the *indenture levels* and the *levels of maintenance* to be applied for the *maintenance* of an *item*.

5503 maintenance

F: maintenance

S: mantenimiento

The combination of all technical and corresponding administrative actions, including supervision actions, intended to retain an *item* in, or restore it to, a state in which it can perform a *required function*.

5504 preventive maintenance

F: maintenance préventive; entretien

S: mantenimiento preventivo

The *maintenance* carried out at predetermined intervals or according to prescribed criteria and intended to reduce the *probability* of *failure* or the degradation of the functioning of an *item*.

5505 corrective maintenance; repair

F: maintenance corrective; réparation; dépannage

S: mantenimiento correctivo; reparación

The *maintenance* carried out after *fault recognition* and intended to restore an *item* to a state in which it can perform a *required function*.

5506 deferred maintenance

F: maintenance différée

S: mantenimiento diferido

Such *corrective maintenance* which is not immediately initiated after a *fault recognition* but is delayed in accordance with given maintenance rules.

5507 scheduled maintenance

F: maintenance programmée; entretien systématique

S: mantenimiento programado

The *preventive maintenance* carried out in accordance with an established time schedule.

5508 unscheduled maintenance

F: maintenance non programmée

S: mantenimiento no programado

The *maintenance* carried out, not in accordance with an established time schedule, but, for example, after reception of an indication regarding the state of an *item*.

5509 on-site maintenance; *in situ* **maintenance; field maintenance**

F: maintenance in situ

S: mantenimiento local; mantenimiento sobre el terreno

Maintenance performed at the premises where the *item* is used.

5510 off-site maintenance

F: maintenance déportée

S: mantenimiento no local

Maintenance performed at a place different from where the *item* is used.

NOTE – An example is the *repair* of a sub-item at a maintenance centre.

5511 remote maintenance

F: télémaintenance

S: mantenimiento remoto; telemantenimiento

Maintenance of an *item* performed without physical access of the personnel to the *item*.

5512 automatic maintenance

F: maintenance automatique

S: mantenimiento automático

Maintenance accomplished without human intervention.

5513 function-affecting maintenance

F: maintenance affectant les fonctions

S: mantenimiento que afecta a la función

A *maintenance action* that affects one or more of the *required functions* of a maintained *item*.

NOTE – *Function-affecting maintenance* is divided into *function-preventing maintenance* and *function-degrading maintenance*.

5514 function-preventing maintenance

F: maintenance-arrêt; maintenance empêchant l'accomplissement des fonctions

S: mantenimiento con discontinuidad de funciones

A *maintenance action* that prevents a maintained *item* from performing a *required function* by causing complete loss of all the functions.

5515 function-degrading maintenance

F: maintenance avec dégradation; maintenance dégradant les fonctions

S: mantenimiento con degradación de funciones

A *maintenance action* that affects one or more of the *required functions* of a maintained *item*, but not to such extent as to cause complete loss of all the functions.

5516 function-permitting maintenance

F: maintenance en fonctionnement; maintenance en exploitation

S: mantenimiento sin discontinuidad de funciones

A *maintenance action* that does not affect any of the *required functions* of a maintained *item*.

5517 level of maintenance

F: niveau de maintenance

S: nivel de mantenimiento

The *maintenance action* to be carried out at a specified *indenture level*.

NOTE – Examples of a *maintenance action* are replacing a component, a printed circuit board, a subsystem, etc.

5518 maintenance echelon; line of maintenance

F: échelon de maintenance

S: escalón de mantenimiento; línea de mantenimiento

The position in an organization where specified *levels of maintenance* are to be carried out on an *item*.

NOTES

1 Examples of *maintenance echelons* are: field, repair shop, manufacturer.

2 The *maintenance echelon* is characterized by the skill of the personnel, the facilities available, the location, etc.

5519 indenture level (for maintenance)

F: niveau d'intervention (pour la maintenance)

S: nivel de intervención (para el mantenimiento)

A level of subdivision of an *item* from the point of view of a *maintenance action*.

NOTES

1 Examples of *indenture levels* could be a subsystem, a circuit board, a component.

2 The *indenture level* depends on the complexity of the item's construction, the accessibility to sub-items, skill level of maintenance personnel, test equipment facilities, safety considerations, etc.

5520 elementary maintenance activity

F: opération élémentaire de maintenance

S: acción elemental de mantenimiento

The unit of work into which a maintenance activity may be broken down at a given *indenture level*.

5521 maintenance action; maintenance task

F: opération de maintenance; tâche de maintenance

S: acción de mantenimiento; tarea de mantenimiento

A sequence of *elementary maintenance activities* carried out for a given purpose.

NOTE – Examples are *fault diagnosis*, *fault localization* and *function check-out* or combinations thereof.

5522 supervision

F: surveillance; supervision

S: supervisión

Activity, performed either manually or automatically, intended to observe the state of an *item*.

NOTE – Automatic *supervision* may be performed internally or externally to the *item*.

5523 controlled maintenance

F: maintenance dirigée

S: mantenimiento dirigido

A method to sustain a desired *quality of service* by the systematic application of analysis techniques using centralized supervisory facilities and/or sampling to minimize *preventive maintenance* and to reduce *corrective maintenance*.

5524 fault recognition

F: détection (de panne)

S: detección (de una avería)

The event when a *fault* is recognized.

5525 fault diagnosis

F: diagnostic (de panne)

S: diagnóstico (de una avería)

Actions taken for *fault recognition*, *fault localization* and cause identification.

5526 fault localization; fault location (deprecated in this sense)

F: localisation de panne

S: localización (de una avería)

Actions taken to identify the *faulty* sub-item or sub-items at the appropriate *indenture level*.

5527 fault correction

F: correction (de panne)

S: corrección (de una avería)

Actions taken after *fault localization* intended to restore the ability of the *faulty item* to perform a *required function*.

5528 function check-out

F: vérification (de fonctionnement)

S: verificación de funcionamiento

Actions taken after *fault correction* to verify that the *item* has recovered its ability to perform the *required function*.

5529 restoration; recovery

F: rétablissement

S: restablecimiento; restauración

That event when the *item* regains the ability to perform a *required function* after a *fault*.

5530 maintenance entity

F: cellule de maintenance

S: célula de mantenimiento; entidad de mantenimiento

A sub-item of a given *item* defined with the intention that an alarm – caused by a *fault* in that sub-item — will be unambiguously referrable to the sub-item.

5.6 Time concepts

See also Figure 3.

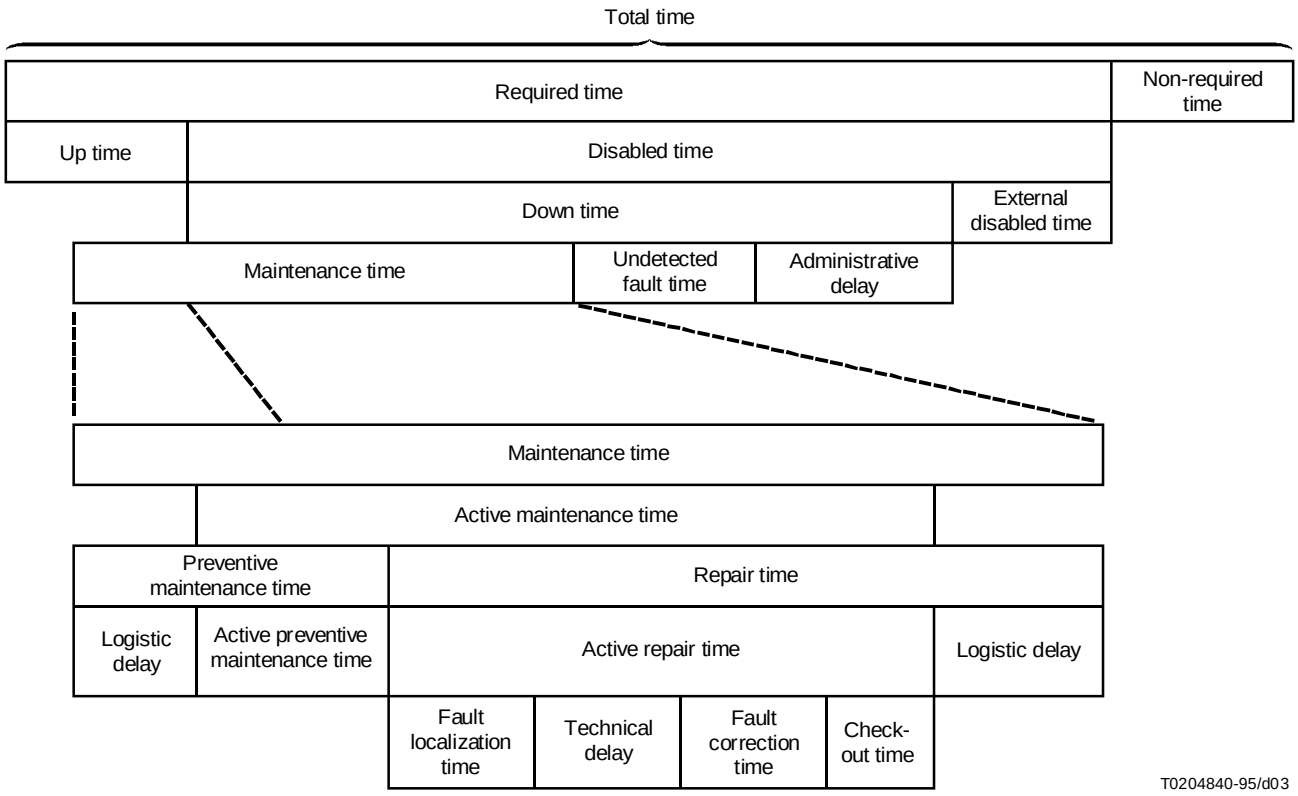


FIGURE 3/E.800

Time diagram

5.6.1 Maintenance related times

5601 maintenance time

F: temps de maintenance

S: tiempo de mantenimiento

The *time interval* during which a *maintenance action* is performed on an *item* either manually or automatically, including *technical delays* and *logistic delays*.

NOTE – *Maintenance* may be carried out while the *item* is performing a *required function*.

5602 maintenance man-hours (MMH)

F: durée équivalente de maintenance (MMH)

S: duración equivalente de mantenimiento; horas-hombre de mantenimiento (MMH)

The accumulated durations of the *maintenance times*, expressed in hours, used by all maintenance personnel for a given type of *maintenance action* or over a given *time interval*.

5603 active maintenance time

F: temps de maintenance active

S: tiempo de mantenimiento activo

That part of the *maintenance time* during which a *maintenance action* is performed on an *item*, either automatically or manually, excluding *logistic delays*.

NOTE – Active maintenance may be carried out while the *item* is performing a *required function*.

5604 preventive maintenance time

F: temps de maintenance préventive

S: tiempo de mantenimiento preventivo

That part of the *maintenance time* during which *preventive maintenance* is performed on an *item*, including *technical delays* and *logistic delays* inherent in *preventive maintenance*.

5605 repair time; corrective maintenance time

F: temps de réparation; temps de maintenance corrective

S: tiempo de reparación; tiempo de mantenimiento correctivo

That part of the *maintenance time* during which *corrective maintenance* is performed on an *item*, including *technical delays* and *logistic delays* inherent in *corrective maintenance*.

5606 active preventive maintenance time

F: temps de maintenance préventive active

S: tiempo de mantenimiento preventivo activo

That part of the *active maintenance time* during which actions of *preventive maintenance* are performed on an *item*.

5607 active repair time; active corrective maintenance time

F: temps de réparation active; temps de maintenance corrective active

S: tiempo de reparación activo; tiempo de mantenimiento correctivo activo

That part of the *active maintenance time* during which actions of *corrective maintenance* are performed on an *item*.

5608 undetected fault time

F: temps de non-détection de panne

S: tiempo de no detección de una avería

The *time interval* between a *failure* and recognition of the resulting *fault*.

5609 administrative delay (for corrective maintenance)

F: délai administratif (pour la maintenance corrective)

S: retardo administrativo (para el mantenimiento correctivo); demora administrativa)

The *accumulated time* during which an action of *corrective maintenance* on a *faulty item* is not performed due to administrative reasons.

5610 logistic delay

F: délai logistique

S: retardo logístico; demora logística

That *accumulated time* during which a *maintenance action* cannot be performed due to the necessity to acquire *maintenance* resources, excluding any *administrative delay*.

NOTE – *Logistic delays* can be due to, e.g. travelling to unattended installations, awaiting the arrival of spare parts, specialists or test equipment.

5611 fault correction time

F: temps de correction de panne

S: tiempo de corrección de una avería

That part of *active repair time* during which *fault correction* is performed.

5612 technical delay

F: délai technique

S: retardo técnico; demora técnica

The *accumulated time* necessary to perform auxiliary technical actions associated with the *maintenance action* itself.

5613 check-out time

F: temps de vérification du fonctionnement

S: tiempo de verificación (de funcionamiento)

That part of *active repair time* during which *function check-out* is performed.

5614 fault localization time; fault location time (deprecated)

F: temps de localisation (de panne)

S: tiempo de localización de una avería

That part of *active repair time* during which *fault localization* is performed.

5.6.2 Item-state related times

5621 operating time

F: temps de fonctionnement

S: tiempo de funcionamiento

The *time interval* during which an *item* is an *operating state*.

5622 non-operating time

F: temps de non-fonctionnement

S: tiempo de no funcionamiento

The *time interval* during which an *item* is in a *non-operating state*.

5623 required time

F: période requise

S: periodo requerido

The *time interval* during which the user requires the *item* to be in a condition to perform a *required function*.

5624 non-required time

F: période non requise

S: periodo no requerido

The *time interval* during which the user does not require the *item* to be in a condition to perform a *required function*.

5625 standby time

F: période d'attente; période de réserve

S: tiempo de espera (en reserva)

The *time interval* during which an *item* is in a *standby state*.

5626 idle time; free time

F: temps libre; période vacante; temps mort

S: tiempo de reposo; tiempo muerto; tiempo libre

The *time interval* during which an *item* is in a *free state*.

5627 disabled time

F: temps d'incapacité

S: tiempo de incapacidad

The *time interval* during which an *item* is in a *disabled state*.

5628 down time

F: temps d'indisponibilité

S: tiempo de indisponibilidad

The *time interval* during which an *item* is in a *down state*.

5629 accumulated down time

F: durée cumulée d'indisponibilité

S: tiempo de indisponibilidad acumulado

The sum of the duration of *down times* over a given *time interval*.

5630 external disabled time; external loss time

F: temps d'incapacité externe

S: tiempo de incapacidad externa

The *time interval* during which an *item* is in an *external disabled state*.

5631 up time

F: temps de disponibilité; temps de bon fonctionnement

S: tiempo de disponibilidad

The *time interval* during which an *item* is in an *up state*.

5.6.3 Time concepts related to reliability performance

5641 time to first failure

F: durée de fonctionnement avant la première défaillance

S: tiempo hasta el primer fallo

Total *time duration* of the *operating time* of an *item* from the *instant of time* it is first put in an *up state*, until *failure*.

5642 time to failure

F: durée de fonctionnement avant défaillance

S: tiempo hasta el fallo

Total *time duration* of the *operating time* of an *item*, from the *instant of time* it goes from a *down state* to an *up state*, after a corrective *maintenance action*, until the next *failure*.

5643 time between failures

F: temps entre défaillances

S: tiempo entre fallos

The *time duration* between two successive *failures* of a *repaired item*.

NOTES

1 Those parts of *non-operating time* which are included must be identified.

2 In some applications only the *up time* is considered.

5644 time to restoration; time to recovery

F: temps de panne

S: tiempo de avería

The *time interval* during which an *item* is in a *down state* due to a *failure*.

5645 useful life

F: (durée de) vie utile

S: vida útil

Under given conditions, the *time interval* beginning at a given *instant of time*, and ending when the *failure intensity* becomes unacceptable or when the *item* is considered unrepairable as a result of a *fault*.

5646 early failure period

F: période initiale de défaillance

S: periodo de fallos inicial

That possible early period in the life of an *item*, beginning at a given *instant of time* and during which the *instantaneous failure intensity* for a *repaired item* or the *instantaneous failure rate* for a *non-repaired item* decreases rapidly.

NOTE – In any particular case, it is necessary to explain what is meant by "decreases rapidly".

5647 constant failure intensity period

F: période d'intensité constante de défaillance

S: periodo de intensidad de fallos constante

That possible period in the life of a *repaired item* during which the *failure intensity* is approximately constant.

NOTE – In any particular case it is necessary to explain what is meant by "approximately constant".

5648 constant failure rate period

F: période de densité constante de défaillance; période de taux constant de défaillance

S: periodo de tasa de fallos constante

That possible period in the life of a *non–repaired item* during which the *failure rate* is approximately constant.

NOTE – In any particular case it is necessary to explain what is meant by "approximately constant".

5649 wear-out failure period

F: période de défaillance par vieillissement; période de défaillance par usure

S: periodo de fallos por envejecimiento

That possible later period in the life of an *item* during which the *instantaneous failure intensity* for a *repaired item* or the *instantaneous failure rate* for a *non–repaired item* increases rapidly.

NOTE – In any particular case it is necessary to explain what is meant by "increases rapidly".

5.7 Test, data, design and analysis concepts

5.7.1 Test concepts

5701 test

F: essai

S: prueba

An experiment made in order to measure or classify a *characteristic*.

5702 compliance test

F: essai de conformité

S: prueba de conformidad

A *test* used to show whether or not a *characteristic* of an *item* complies with the stated requirements.

5703 determination test

F: essai de détermination

S: prueba de determinación

A *test* used to establish the value of a *characteristic*.

5704 laboratory test

F: essai en laboratoire

S: prueba de laboratorio

A *compliance test* or a *determination test* made under prescribed and controlled conditions which may or may not simulate field conditions.

5705 field test

F: essai en exploitation

S: prueba en condiciones de explotación; prueba en condiciones reales

A *compliance test* or *determination test* made in the field where operating, environmental, maintenance and measurement conditions are recorded.

5706 endurance test

F: essai d'endurance

S: prueba de resistencia

A *test* carried out over a *time interval* to investigate how the properties of an *item* are affected by the application of stated stresses and by their *time duration*.

5707 accelerated test

F: essai accéléré

S: prueba acelerada

A *test* in which the applied stress level is chosen to exceed that stated in the reference conditions in order to shorten the *time duration* required to observe the stress response of the *item*, or to magnify the responses in a given *time duration*.

NOTE – To be valid, an *accelerated test* shall not alter the basic *fault modes* and *failure mechanisms*, or their relative prevalence.

5708 step stress test

F: essai sous contrainte échelonnée

S: prueba de esfuerzo escalonado

A *test* consisting of several stress levels applied sequentially for periods of equal *time duration* to an *item*, in such a way that during each *time interval* a stated stress level is applied and the stress level is increased from one *time interval* to the next.

5709 screening test

F: essai de sélection

S: prueba de selección

A *test*, or combination of *tests*, intended to remove or detect unsatisfactory *items* or those likely to exhibit early *failures*.

5710 time acceleration factor

F: facteur d'accélération temporelle

S: factor de aceleración temporal

The ratio between the *time durations* necessary to obtain the same stated number of *failures* or degradations in two equal size samples under two different sets of stress conditions involving the same *failure mechanisms* and *fault modes* and their relative prevalence.

NOTE – One of the two sets of stress conditions should be a reference set.

5711 maintainability verification

F: vérification de la maintenabilité

S: verificación de la mantenibilidad

A procedure applied for the purpose of determining whether the requirements for *maintainability performance measures* for an *item* has been achieved or not.

NOTE – The procedures may range from analysis of appropriate data to a *maintainability demonstration*.

5712 maintainability demonstration

F: vérification expérimentale de maintenabilité

S: demostración de la mantenibilidad

A *maintainability verification* performed as a *compliance test*.

5.7.2 Data concepts

5721 observed data

F: valeur observée; donnée observée

S: datos observados; valores observados

Values related to an *item* or a process obtained by direct observation.

NOTE – Values referred to could be events, *time instants*, *time intervals*, etc.

5722 test data

F: données d'essai

S: datos de prueba

Observed data obtained during *tests*.

5723 field data

F: donnée d'exploitation

S: datos de explotación

Observed data obtained during field operation.

5724 reference data

F: valeur de référence; données de référence

S: datos de referencia; valores de referencia

Data, which by general agreement may be used for *prediction* and/or comparison with *observed data*.

5.7.3 Design concepts

5731 redundancy

F: redondance

S: redundancia

In an *item*, the existence of more than one means for performing a *required function*.

5732 active redundancy

F: redondance active

S: redundancia activa

That *redundancy* wherein all means for performing a *required function* are intended to operate simultaneously.

5733 standby redundancy

F: redondance en attente; redondance passive; redondance en secours; redondance en réserve

S: redundancia pasiva; redundancia de reserva

That *redundancy* wherein one means for performing a *required function* is intended to operate, while the alternative means are inoperative until needed.

5734 fail safe

F: protégé contre défaillances critiques; à sûreté intégrée

S: prevención de fallos

A designed property of an *item* which prevents its *failures* from resulting in *critical faults*.

5735 fault tolerance

F: tolérance aux pannes

S: tolerancia a las averías

The attribute of an *item* that makes it able to perform a *required function* in the presence of certain given sub-item *faults*.

5736 fault masking

F: masquage de panne

S: enmascaramiento de avería

The condition in which a *fault* exists in a sub-item of an *item* but cannot be recognized because of a feature of the *item* or because of another *fault* of the sub-item or of another sub-item.

5.7.4 Analysis concepts

5741 prediction

F: prévision; prédiction

S: previsión; predicción

1) The process of computation used to obtain (a) *predicted* value(s) of a quantity.

2) The *predicted* value(s) of a quantity.

5742 reliability model

F: modèle de fiabilité

S: modelo de fiabilidad

A mathematical model used for *prediction* or *estimation* of *reliability measures* of an *item* or for similar purposes.

5743 fault modes and effects analysis (FMEA)

F: analyse des modes de panne et de leurs effets (FMEA)

S: análisis de los modos de avería y de sus efectos (FMEA)

A qualitative method of *reliability* analysis which involves the study of the *fault modes* which can exist in every sub-item of the *item* and the determination of the effects of each *fault mode* on other sub-items of the *item* and on the *required functions* of the *item.*

5744 fault modes, effects and criticality analysis (FMECA)

F: analyse des modes de panne, de leurs effets et de leur criticité (FMECA)

S: análisis de los modos de avería, sus efectos y su criticidad (FMECA)

Fault modes and effect analysis together with a consideration of the *probability* of occurrence and a ranking of the seriousness of the *fault.*

5745 fault tree analysis (FTA)

F: analyse par arbre de panne (FTA)

S: análisis arborescente de averías (FTA)

An analysis to determine which *fault modes* of the sub-items or external events, or combinations thereof, may result in a stated *fault mode* of the *item*, resulting in a *fault tree*.

5746 stress analysis

F: analyse de contraintes

S: análisis de esfuerzos

A quantitative or qualitative determination of the physical, chemical or other stresses an *item* is subjected to under given use conditions.

5747 reliability block diagram

F: diagramme de fiabilité

S: diagrama de bloques de fiabilidad

Block diagram showing, for one or more *functional modes* of a complex *item*, how *faults* of the sub-items represented by the blocks, or combinations thereof, result in a *fault* of the *item*.

5748 fault tree

F: arbre de panne

S: árbol de averías

A logic diagram showing which *fault modes* of sub-items or external events, or combinations thereof, result in a given *fault mode* of the *item.*

5749 state-transition diagram

F: diagramme de transition d'états

S: diagrama de transición de estados

A diagram showing the set of possible states of an *item* and the possible one step transitions between these states.

5750 stress model

F: modèle de contraintes

S: modelo de esfuerzos

A mathematical model which describes how a *reliability performance measure* of an *item* varies as a function of the applied stresses.

5751 fault analysis

F: analyse des pannes

S: análisis de averías

The logical, systematic examination of an *item* or its diagram(s) to identify and analyse the *probability*, causes and consequences of potential and real *faults*.

5752 maintainability model

F: modèle de maintenabilité

S: modelo de mantenibilidad

A mathematical model used for *prediction* or *estimation* of *maintainability performance measures* of an *item* or for similar purposes.

NOTE – An example is the *maintenance tree*.

5753 maintainability prediction

F: prévision de maintenabilité; prédiction de maintenabilité

S: previsión de la mantenibilidad; predicción de la mantenibilidad

An activity performed with the intention to forecast the numerical values of a *maintainability performance measure* of an *item*, taking into account the *maintainability performance* and *reliability performance measures* of its sub-items, under given operational and maintenance conditions.

5754 maintenance tree

F: arbre de maintenance

S: árbol de mantenimiento

A logic diagram showing the pertinent alternative sequences of *elementary maintenance activities* to be performed on an *item* and the conditions for their choice.

5755 maintainability allocation; maintainability apportionment

F: répartition de la maintenabilité

S: distribución de la mantenibilidad; asignación de la mantenibilidad

A procedure applied during the design of an *item* intended to apportion the requirements for *maintainability performance measures* for an *item* to its sub-items according to given criteria.

5.7.5 Improvement processes

5761 learning process

F: apprentissage

S: aprendizaje

Growth in experience and familiarity by personnel with design or constructional techniques, which reduces the risk of future *mistakes*.

5762 burn-in

F: rodage

S: rodaje

A process of *reliability improvement* of hardware, employing operation of every *item* in a prescribed environment, with successive *fault correction*, replacement or removal at every *failure*, during the steeply falling *failure intensity* period within the *early failure period*.

5763 reliability growth

F: croissance de la fiabilité

S: crecimiento de la fiabilidad; incremento de la fiabilidad

A condition characterized by a progressive improvement of a *reliability performance measure* of an *item*, or population of similar *items*, with time.

NOTE – A growth can result either from active improvement or from *burn-in*.

5764 reliability improvement

F: amélioration de fiabilité

S: mejora de la fiabilidad

A process undertaken with the deliberate intention of promoting *reliability growth* by the elimination of *systematic faults*.

5765 maintainability programme

F: programme de maintenabilité

S: programa de mantenibilidad

A detailed plan, including the human and material resources, procedures, tasks and responsibilities during the life of an *item*, intended to determine the fulfilment of the requirements for *maintainability performance measures* for an *item* and facilitate the planning of the *maintenance*.

Annex A

Related QoS/NP Handbooks and E-Series Recommendations

(This annex forms an integral part of this Recommendation)

Handbooks

CCITT Manual on Quality of Service, Network Management and Maintenance, ITU, Geneva, 1984.

CCITT Handbook on Quality of Service and Network Performance, ITU, Geneva, 1993.

Recommendations

E.420 Checking the quality of the international telephone service - General considerations.

E.421 Service quality observations on a statistical basis.

E.422 Observations on international outgoing telephone calls for quality of service.

E.423 Observations on traffic set up by operators.

E.424 Test calls.

E.425 International automatic observations.

E.426 General guidance to the percentage of effective attempts which should be observed for international telephone calls.

E.427 Collection and statistical analysis of special quality of service observation data for measurements of customer difficulties in the international automatic service.

E.428 Connection retention.

E.430 Quality of service framework.

E.431 Service quality assessment for connection set up and release delays.

E.432 Connection quality.

E.433 Billing integrity.

E.434 Subscriber to subscriber measurement of the public switched telephone network.

E.450 Facsimile quality of service on PSTN – General aspects.

E.451 Facsimile call cut-off performance.

E.452 Facsimile modem speed reductions and transaction time.

E.505 Measurements of the performance of common channel signalling networks.

E.525 Designing networks to control grade of service.

E.540 Overall grade of service of the international part of an international connection.

E.541 Overall grade of service for international connections (subscriber to subscriber).

E.543 Grades of service in digital international telephone exchanges.

E.550 Grade of service and new performance criteria under failure.

E.600 Terms and definitions of traffic engineering.

E.720 ISDN grade of service concept.

E.721 Network grade of service parameters in ISDN.

E.723 GOS parameters for Signalling System No. 7 networks.

E.733 Methods for dimensioning resources in Signalling System No. 7 networks.

E.770 Land mobile and fixed network interconnection traffic grade of service concept.

E.771 Network grade of service parameters and target values for circuit-switched quality of service and dependability vocabulary.

E.810 Framework of the Recommendations on the serveability performance and integrity for telecommunication services.

E.820 Call models for serveability and service integrity performance.

E.830 Models for the specification, evaluation and allocation of serveability and service integrity.

E.845 Connection accessibility objective for the international telephone service.

E.846 Accessibility for 64 kbit/s switched international end-to-end ISDN connection types.

E.850 Connections retainability objective for the international telephone service.

E.855 Connection integrity objective for the international telephone service.

E.862 Dependability planning of telecommunication networks.

E.880 Field data collection and evaluation on the performance of equipment, networks and services.

Annex B

Relations between defect, failure and fault concepts

(This annex forms an integral part of this Recommendation)

TABLE B.1/E.800

Defect	Failure	Fault
Critical defect	Critical failure	Critical fault
Non-critical defect	Non-critical failure	Non-critical fault
Major defect	–	Major fault
Minor defect	–	Minor fault
–	Misuse failure	Misuse fault
–	Mishandling failure	Mishandling fault
–	Inherent weakness failure	Inherent weakness fault
Design defect	Design failure	Design fault
Manufacturing defect	Manufacturing failure	Manufacturing fault
–	Ageing failure	Ageing fault
–	Sudden failure	–
–	Gradual failure	–
–	Cataleptic failure	–
–	Relevant failure	–
–	Non-relevant failure	–
–	Primary failure	–
–	Secondary failure	–
–	Failure cause	–
–	Failure mechanism	–
–	–	Programme-sensitive fault
–	–	Data-sensitive fault
–	–	Complete fault
–	–	Partial fault
–	–	Persistent fault
–	–	Intermittent fault
–	–	Fault mode
–	–	Determinate fault
–	–	Indeterminate fault
–	–	Latent fault
–	Systematic failure	Systematic fault
Bug	–	–

Annex C

List of recommended symbols and abbreviations

(This annex forms an integral part of this Recommendation)

α	Significance level
β	Type II risk
$\lambda(t)$	Instantaneous failure rate
$\bar{\lambda}(t_1, t_2)$	Mean failure rate [in time interval (t_1, t_2)]
$\mu(t)$	Instantaneous repair rate
$\bar{\mu}(t_1, t_2)$	Mean repair rate [in time interval (t_1, t_2)]
δ	Standard deviation
A	Asymptotic availability
$A(t)$	Instantaneous availability
$\bar{A}$	Asymptotic mean availability
$\bar{A}(t_1, t_2)$	Mean availability [in time interval (t_1, t_2)]
ASR	Answer seizure ratio
$E(X)$	Mean (of X)
$f(x)$	Probability density function
$F(x)$	Distribution function
FMEA	Fault modes and effect analysis
FMECA	Fault modes, effects and criticality analysis
FTA	Fault tree analysis
H_0	Null hypothesis
H_1	Alternative hypothesis
MAD	Mean administrative delay
MADT	Mean accumulated down time
MART	Mean active repair time
MDT	Mean down time
MID	Mean interruption duration
MLD	Mean logistic delay
MMH	Maintenance man-hours
MRT	Mean repair time
MTBF	Mean time between failures
MTBI	Mean time between interruptions

MTTF	Mean time to failure
MTTFF	Mean time to first failure
MTTR	Mean time to restoration
MUT	Mean up time
$N(t_1, t_2)$	Number of failures [in time interval (t_1, t_2)]
R	Reliability
U	Asymptotic unavailability
$U(t)$	Instantaneous unavailability
$\overline{U}$	Asymptotic mean unavailability
$\overline{U}(t_1, t_2)$	Mean unavailability [in time interval (t_1, t_2)]
$z(t)$	Instantaneous failure intensity
$\overline{z}(t_1, t_2)$	Mean failure intensity [in time interval (t_1, t_2)]

INDEX

Alphabetical list of definitions contained in this Recommendation

Accelerated test 5707
Acceptable level (of a mesure) 5439
Accessibility of a connection to be established 3317
Accumulated down time 5629
Active corrective maintenance time 5607
Active maintenance time 5603
Active preventive maintenance time 5606
Active redundancy 5732
Active repair time 5607
Administrative delay (for corrective maintenance) 5609
Ageing failure 5329
Ageing fault 5351
Alternative hypothesis 5417
Asymptotic availability 4215
Asymptotic mean availability 4217
Asymptotic mean unavailability 4218
Asymptotic unavailability 4216
Automatic maintenance 5512
Availability performance 4210
Average ... 5207
Billing error probability 3102
Billing integrity (probability) 3106
Bit error ratio (BER) 4301
Break (of service) 3341
Bug 5302
Burn-in 5762
Busy state 5389
Call abandonment probability 3204
Capability 2307
Cataleptic failure 5332
Catastrophic failure 5332
Characteristic 5401
Charging correctness 4401
Check-out time 5613
Complete fault 5354
Compliance test 5702
Confidence coefficient 5437
Confidence interval 5431
Confidence level 5437
Confidence limit 5433
Connection 2304
Connection accessibility 3314
Connection retainability 3332
Constant failure intensity period 5647
Constant failure rate period 5648
Consumer's risk (point) 5426
Controlled maintenance 5523
Corrective maintenance 5505
Corrective maintenance time 5605
Critical defect 5303
Critical defective item 5308
Critical failure 5322
Critical fault 5342
Critical region 5418
Critical state 5390

Critical values 5419
Cut-off probability 3334
Data-sensitive fault 5353
Defect 5301
Defective 5307
Defective item 5307
Deferred maintenance 5506
Degradation failure 5331
Dependability 4200
Design defect 5311
Design failure 5327
Design fault 5349
Determinate fault 5358
Determination test 5703
Deterministic failure 5339
Dialling mistake probability 3202
Disabled state 5385
Disabled time 5627
Distribution function 5405
Down state 5387
Down time 5628
Drift failure 5331
Durability 5102
Early failure period 5646
Effectiveness (performance) 5101
Element 2302
Elementary maintenance activity 5520
Endurance test 5706
Entity 2302
Error 5371
Error free seconds (EFS) 4302
Error of the first kind 5420
Error of the second kind 5422
Estimate 5435
Estimated ... 5204
Estimation 5434
Estimator 5436
Execution error 5372
Expectation (of a random variable) 5408
External disabled state 5386
External disabled time 5630
External loss time 5630
Extrapolated ... 5203
Fail safe 5734
Failure 5321
Failure cause 5337
Failure intensity acceleration factor 4240
Failure mechanism 5338
Failure mode 5362
Failure rate acceleration factor 4239
Fault 5341
Fault analysis 5751
Fault correction 5527
Fault correction time 5611
Fault coverage 4261
Fault diagnosis 5525
Fault localization 5526
Fault localization time 5614
Fault location 5526
Fault location time 5614
Fault masking 5736
Fault mode 5362
Fault modes and effects analysis (FMEA) 5743
Fault modes, effects and critically analysis (FMECA) 5744
Fault recognition 5524
Fault tolerance 5735
Fault tree 5748
Fault tree analysis (FTA) 5745
Faulty 5363
Field data 5723
Field maintenance 5509
Field test 5705
Free state 5384
Free time 5626
Function check-out 5528
Function preventing fault 5354
Function-affecting maintenance 5513
Function-degrading maintenance 5515
Function-permitting maintenance 5516
Function-preventing maintenance 5514
Generated error 5372
Gradual failure 5331
Idle state 5384
Idle time 5626
Imperfection 5306
In situ maintenance 5509
Incorrect charging or accounting probability 3103
Indenture level (for maintenance) 5519
Indeterminate fault 5359
Inherent ... 5205
Inherent weakness failure 5326
Inherent weakness fault 5348
Instantaneous ... 5209
Instantaneous availability 4211
Instantaneous availability of a leased circuit 4221
Instantaneous failure intensity 4234
Instantaneous failure rate 4232
Instantaneous repair rate 4252
Instantaneous unavailability 4212
Interaction error (man-machine) 5373
Intermittent fault 5357
Internal disabled state 5387
Interruption 3341
Interruption duration 3343
Intrinsic ... 5205
Item 2302
Laboratory test 5704
Latent fault 5360
Learning process 5761
Level of maintenance 5517
Line of maintenance 5518
Logistic delay 5610
Maintainability 4251
Maintainability allocation 5755
Maintainability apportionment 5755
Maintainability demonstration 5712
Maintainability model 5752
Maintainability performance 4250
Maintainability prediction 5753
Maintainability programm 5765
Maintainability verification 5711

Maintenance 5503
Maintenance action 5521
Maintenance echelon 5518
Maintenance entity (ME) 5530
Maintenance man-hours (MMH) 5602
Maintenance philosophy 5501
Maintenance policy 5502
Maintenance support performance 4270
Maintenance task 5521
Maintenance time 5601
Maintenance tree 5754
Major defect 5305
Major defective item 5309
Major fault 5344
Manufacturing defect 5312
Manufacturing failure 5328
Manufacturing fault 5350
Mean (of a random variable) 5408
Mean ... 5207
Mean access delay 3315
Mean accumulated down time (MADT) 4220
Mean active repair time (MART) 4258
Mean administrative delay (MAD) 4271
Mean availability 4213
Mean down time (MDT) 4255
Mean failure intensity 4235
Mean failure rate 4233
Mean interruption duration (MID) 3345
Mean logistic delay (MLD) 4273
Mean maintenance man-hours 4254
Mean repair rate 4253
Mean repair time (MRT) 4256
Mean service access delay 3312
Mean service provisioning time 3101
Mean time between failures (MTBF) 4238
Mean time between interruptions (MTBI) 3344
Mean time to failure (MTTF) 4237
Mean time to first failure (MTTFF) 4236
Mean time to recovery 4260
Mean time to repair 4260
Mean time to restoration (MTTR) 4260
Mean unavailability 4214
Mean up time (MUT) 4219
Minor defect 5306
Minor defective item 5310
Minor fault 5345
Mishandling failure 5325
Mishandling fault 5347
Misrouting probability 3320
Mistake 5375
Misuse failure 5324
Misuse fault 5346
Modification (of an item) 5103
Network accessibility 3313
Network performance 2201
No tone probability 3319
Non-critical defect 5304
Non-critical failure 5323
Non-critical fault 5343
Non-operating state 5382
Non-operating time 5622
Non-relevant failure 5334
Non-required time 5624
Null hypothesis 5416
Observed data 5721
Observed value (in statistics) 5411
OC curve (for a statistical test plan) 5424
Off-site maintenance 5510
On-site maintenance 5509
One-sided test 5414
Operating characteristic curve 5424
Operating state 5381
Operating time 5621
Operational ... 5206
Outage 5385
Overcharging probability 3105
p-fractile 5407
p-fractile ... 5208
p-fractile access delay 3316
p-fractile active repair time 4259
p-fractile administrative delay 4272
p-fractile logistic delay 4274
p-fractile repair time 4257
p-quantile (of a probability distribution) 5407
Partial fault 5355
Permanent fault 5356
Persistent fault 5356
Pointwise availability 4211
Pointwise unavailability 4212
Power of the test 5427
Predicted ... 5202
Prediction 5741
Premature release probability 3334
Preventive maintenance 5504
Preventive maintenance time 5604
Primary failure 5335
Probability 5402
Probability density function (PDF) 5406
Probability of acceptance 5429
Probability of rejection 5430
Probability of successful service completion 3336
Producer’s risk (point) 5425
Programme-sensitive fault 5352
Propagated error 5374
Propagation performance 4303
Quality of service 2101
Random process 5404
Random variable 5403
Recovery 5529
Redundancy 5731
Reference data 5724
Relative frequency 5412
Release failure probability 3335
Relevant failure 5333
Reliability 4231
Reliability block diagram 5747
Reliability growth 5763
Reliability improvement 5764
Reliability model 5742
Reliability performance 4230

Remote maintenance 5511
Repair 5505
Repair coverage 4262
Repair time 5605
Reproducible failure 5339
Required time 5623
Resource 2306
Restoration 5529
Retainability of an established connection 3333
Scheduled maintenance 5507
Screening test 5709
Secondary failure 5336
Serveability performance 3300
Service 2301
Service access probability 3311
Service accessibility 3311
Service accessibility performance 3310
Service integrity performance 3340
Service operability performance 3200
Service retainability 3331
Service retainability performance 3330
Service security performance 3400
Service support performance 3100
Service user abandonment probability 3203
Service user mistake probability 3201
Significance level (of a statistical test) 5428
Solid fault 5356
Standby time 5625
Standard deviation 5410
Standby redundancy 5733
Standby state 5383
State-transition diagram 5749
Statistic 5438
Statistical test 5413
Statistical tolerance interval 5432
Steady-state availability 4215
Step stress test 5708
Stress analysis 5746
Stress model 5750
Sudden failure 5330
Supervision 5522
Systematic failure 5339
Systematic fault 5361
Technical delay 5612
Telecommunications traffic 2305
Teletraffic 2305
Test 5701
Test data 5722
Time acceleration factor 5710
Time between failures 5643
Time between interruptions 3342
Time to failure 5642
Time to first failure 5641
Time to recovery 5644
Time to restoration 5644
Trafficability performance 4100
Transient fault 5357
Transmission performance 4300
True ... 5201
Two-sided test 5415
Type I risk 5421
Type II risk 5423
Unacceptable transmission probability 3318
Undercharging probability 3104
Undetected fault time 5608
Unscheduled maintenance 5508
Up state 5388
up time 5631
Useful life 5645
User 2303
Variance (of a random variable) 5409
Variate 5403
Volatile fault 5357
Wear-out failure period 5649
Wearout failure 5329
Wearout fault 5351