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SERIES I: INTEGRATED SERVICES DIGITAL
NETWORK

Overall network aspects and functions – Performance
objectives

**Relationships among ISDN performance
Recommendations**

ITU-T Recommendation I.351

(Previously CCITT Recommendation)

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INTEGRATED SERVICES DIGITAL NETWORK

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ITU-T RECOMMENDATION I.351

RELATIONSHIPS AMONG ISDN PERFORMANCE RECOMMENDATIONS

Summary

Recommendation I.351 defines a general structure for a set of existing and draft Recommendations that collectively provide the basis for the specification and apportionment of performance in narrowband and broadband Integrated Services Digital Networks (ISDNs), including network synchronization and timing performance. These Recommendations are intended to be used in describing performance between the measurement points that delimit and apportion international ISDNs.

Source

ITU-T Recommendation I.351 was revised by ITU-T Study Group 13 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 20th of June 1997.

FOREWORD

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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.

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

NOTE

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

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Recommendation I.351

RELATIONSHIPS AMONG ISDN PERFORMANCE RECOMMENDATIONS

(revised in 1997)

1 Scope

Recommendation I.351 defines relationships among the following existing and draft ITU-T Recommendations: G.810, G.811, G.812, G.813, G.821, G.822, G.823, G.824, G.825, G.826, G.827, G.EPMRS, I.350, I.351, I.352, I.353, I.354, I.355, I.356, I.357, I.35bcp, and I.35D. Collectively, these Recommendations provide the basis for the specification and apportionment of performance in narrowband and broadband ISDNs, including network synchronization and timing performance. These Recommendations are intended to be used in describing performance between the measurement points that delimit and apportion international ISDNs.

The relevant Recommendations and their relationships are illustrated in Figure 1. The 3×3 performance description framework defined in Recommendation I.350 is used to illustrate the relationships among particular Recommendations. Three protocol-independent telecommunication functions are identified in the matrix: access, user information transfer, and disengagement. These general functions correspond to specified aspects of ISDN services conforming to ITU-T standardized protocols¹. Each function is considered with respect to three general performance concerns (or "performance criteria"): speed, accuracy, and dependability. These express, respectively, the delay or rate, degree of correctness, and degree of certainty with which the function is performed. Recommendations shown within the matrix define sets of protocol-specific parameters ("primary parameters") that describe performance criteria relative to each function. An associated model provides a basis for describing overall service availability. A specified availability function compares the values for a subset of the primary parameters with corresponding outage thresholds to classify the services as "available" (no service outage) or "unavailable" (service outage) during scheduled service time. Figure 1 presents the Recommendations that specify availability functions and define availability parameters associated with ISDN services. Recommendations concerning timing and synchronization performance of digital networks including ISDNs are illustrated in Figure 1 by their relationships to the complementary aspects of network synchronization and timing equipment performance description.

The general scope and content of each Recommendation illustrated in Figure 1 is described in clause 3².

¹ For B-ISDN, these general functions include multiparty and multipoint connection types.

² The most recent editions of draft and approved Recommendations should be consulted.

General Aspects of ISDN Performance

I.350 (Quality of Service/Network Performance Framework)
I.351 (Relationships Among ISDN Performance Recommendations)
I.353 (Performance Model)

N-ISDN Performance (CKT = circuit mode, PKT = packet mode)				B-ISDN Performance (CKT = circuit mode, ATM = ATM cell transfer)			
Criteria Function	Speed	Accuracy	Dependability	Criteria Function*	Speed	Accuracy	Dependability
Access	I.352 (CKT) I.354 (PKT)	I.35D (CKT) I.354 (PKT)	I.35D (CKT) I.354 (PKT)	Access	I.35bcp (B-ISDN)	I.35bcp (B-ISDN)	I.35bcp (B-ISDN)
Information Transfer	I.354 (PKT)	G.821 (CKT) G.826 (CKT) I.354 (PKT)	I.35D (CKT) I.354 (PKT)	Information Transfer	I.356 (ATM)	G.826 (CKT) G.EPMRS (CKT) I.356 (ATM)	I.356 (ATM)
Disengagement	I.352 (CKT) I.354 (PKT)	I.35D (CKT) I.354 (PKT)	I.35D (CKT) I.354 (PKT)	Disengagement	I.35bcp (B-ISDN)	I.35bcp (B-ISDN)	I.35bcp (B-ISDN)
Availability				Availability			
I.355 (CKT) I.355 (PKT)				G.827 (CKT) I.357 (ATM)			

* Including multiparty, multipoint functionality

Timing and Synchronization Performance	
Network Synchronization	Timing Equipment
G.810 (Terminology) G.822 (Slips) G.823 (Jitter/Wander – 2048 kbit/s Hierarchy) G.824 (Jitter/Wander – 1544 kbit/s Hierarchy) G.825 (Jitter/Wander – SDH)	G.810 (Terminology) G.811 (Primary Reference Clock) G.812 (Synchronization Supply Unit) G.813 (SDH Equipment Clock)

Figure 1/I.351 – Relationships among ISDN performance Recommendations

2 Abbreviations

This Recommendation uses the following abbreviations:

ADEV	Allan Deviation
ATM	Asynchronous Transfer Mode
B-ISDN	Broadband ISDN
CBR	Constant Bit Rate
CKT	Circuit Mode
FFM	Flicker Frequency Modulation
FPM	Flicker Phase Modulation
ISDN	Integrated Services Digital Network
kbit/s	kilobit/second
MDEV	Modified Allan Deviation
MRTIE	Maximum Relative Time Interval Error
MTIE	Maximum Time Interval Error
N-ISDN	Narrowband ISDN
NP	Network Performance
PDH	Plesiochronous Digital Hierarchy
PKT	Packet Mode
PRC	Primary Reference Clock
QOS	Quality of Service
RMS	Root Mean Square
RWFM	Random Walk Frequency Modulation
SDH	Synchronous Digital Hierarchy
SEC	SDH Equipment Clock
SSU	Synchronization Supply Unit
STM	Synchronous Transport Module
TDEV	Time Deviation
TIErms	Root Mean Square Time Interval Error
TVAR	Time Variance
UTC	Universal Co-ordinated Time
VC	Virtual Channel
WFM	White Frequency Modulation

3 General scope and content of ISDN performance Recommendations

The general scope and content of each of the ISDN performance Recommendations identified in Figure 1 is provided below. (For ease of reference, the Recommendations are listed alphanumerically.)

Recommendation G.810 – Definitions and terminology for synchronization networks (1996)

Recommendation G.810 provides definitions and terms for describing network synchronization performance. These definitions and terms are used in Recommendations G.811, G.812, G.813, G.822, G.823, G.824, and G.825.

Recommendation G.811 – Timing requirements at the outputs of primary reference clocks suitable for plesiochronous operation of international digital links (1988)

Recommendation G.811 (revised draft) defines parameters and objectives for describing Primary Reference Clock (PRC) performance. The parameter definitions utilize Recommendation G.810 terminology. Key parameters are MTIE, TDEV, total phase, and peak-to-peak jitter. The parameters and objectives apply to PRC jitter and wander performance. This Recommendation provides part of the basis for the slip performance objectives in Recommendation G.822 and the wander reference model in Recommendation G.823.

Recommendation G.812 – Timing requirements at the output of slave clocks suitable for plesiochronous operation of international digital links (1988)

Recommendation G.812 (revised draft) defines parameters and objectives for describing timing equipment synchronization supply unit performance. The parameter definitions utilize Recommendation G.810 terminology. Key parameters are MTIE, MRTIE, TDEV, total phase, and peak-to-peak jitter. The parameters and objectives apply to slave clock jitter, wander, transient, and holdover performance.

Recommendation G.813 – Timing characteristics of SDH equipment slave clocks (SEC) (1996)

Recommendation G.813 defines timing equipment parameters and objectives for describing SDH equipment clock performance. The parameter definitions utilize Recommendation G.810 terminology. Key parameters are MTIE, TDEV, total phase, and peak-to-peak jitter. The parameters and objectives apply to interfaces of "Option 1" and "Option 2" SDH equipment clocks. Option 1 applies to SDH networks optimized for the 2048 kbit/s hierarchy and Option 2 applies to SDH networks optimized for the particular 1544 kbit/s hierarchy that includes the rates 1544 kbit/s, 6312 kbit/s, and 44 736 kbit/s.

Recommendation G.821 – Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network (1996)

Recommendation G.821 defines accuracy parameters and objectives for describing N-ISDN circuit mode information transfer performance. Key parameters are errored second ratio and severely errored second ratio. The parameters and objectives apply to specified portions of an international end-to-end digital connection operating at a bit rate below the primary rate. This Recommendation provides a basis for N-ISDN circuit mode availability performance specified in Recommendation I.355.

Recommendation G.822 – Controlled slip rate objectives on an international digital connection (1988)

Recommendation G.822 defines parameters and objectives for describing network slip performance. The parameter definitions utilize Recommendation G.810 terminology. Key parameters are the mean slip rate and its associated proportion of time. The parameters and objectives apply to specified portions of an international digital connection. This Recommendation provides a basis for Option 1 and Option 2 network wander limits in Recommendation G.813.

Recommendation G.823 – The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy (1993)

Recommendation G.823 defines parameters and objectives for describing network jitter and wander performance based on the 2048 kbit/s hierarchy. The parameter definitions utilize Recommendation G.810 terminology. Key parameters are peak-to-peak jitter and wander, RMS jitter, and associated measurement filter bandwidths. The parameters and objectives apply to jitter and wander tolerance and network limits for PDH interfaces based on the 2048 kbit/s hierarchy and to jitter and wander transfer for equipment with PDH interfaces based on the 2048 kbit/s hierarchy.

Recommendation G.824 – The control of jitter and wander within digital networks which are based on the 1544 kbit/s hierarchy (1993)

Recommendation G.824 defines parameters and objectives for describing network jitter and wander performance based on the 1544 kbit/s hierarchy. The parameter definitions utilize Recommendation G.810 terminology. Key parameters are peak-to-peak jitter and wander, RMS jitter, and associated measurement filter bandwidths. The parameters and objectives apply to jitter and wander tolerance and network limits for PDH interfaces based on the 1544 kbit/s hierarchy and to jitter and wander transfer for equipment with PDH interfaces based on the 1544 kbit/s hierarchy. This Recommendation provides input to the Option 2 wander budget and network wander limits in Recommendation G.813.

Recommendation G.825 – The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (1993)

Recommendation G.825 defines parameters and objectives for describing network synchronization jitter and wander performance based on the SDH. The parameter definitions utilize Recommendation G.810 terminology. Key parameters are peak-to-peak jitter and wander, RMS jitter, and associated measurement filter bandwidths. The parameters and objectives apply to jitter and wander tolerance and network limits for SDH interfaces based on the SDH hierarchy. This Recommendation provides part of the basis for the Option 1 SEC bandwidth specification in Recommendation G.813.

Recommendation G.826 – Error performance parameters and objectives for international constant bit rate digital paths at or above the primary rate (1996)

Recommendation G.826 defines accuracy parameters and objectives for describing B-ISDN circuit mode information transfer performance. The key parameters are errored second ratio, severely errored second ratio, and background block-error ratio. The parameters and objectives apply to specified portions of an international end-to-end CBR digital path operating at or above the primary rate.

Recommendation G.827 – Availability performance and objectives for path elements of international constant bit rate digital paths at or above the primary rate (1996)

Recommendation G.827 defines parameters and (planned) objectives for describing B-ISDN circuit mode availability performance. The parameters are defined on the basis of G.826 parameter thresholds. Key parameters are availability ratio and mean time between digital path outages. The parameters and (planned) objectives apply to path elements of an end-to-end international CBR digital path at or above the primary rate.

Recommendation G.EPMRS – Error performance events for SDH multiplex and regenerator sections (planned)

Recommendation G.EPMRS (draft) defines error performance events and block structures applicable to error performance assessment on SDH multiplex sections. The Recommendation defines the events errored second, severely errored second, and background block errors. Block structures are given for bit rates less than STM-1, STM-1 to STM-16, and STM-64.

Recommendation I.350 – General aspects of quality of service and network performance in digital networks, including ISDNs (1993)

Recommendation I.350 defines Quality of Service (QOS) and Network Performance (NP) principles; illustrates how the QOS and NP concepts are applied in digital networks including ISDNs (providing both narrowband and broadband capabilities); describes the features of, and the relationships between, these concepts; indicates and classifies performance concerns for which parameters may be needed; and identifies generic performance parameters.

Recommendation I.351 – Relationships among ISDN performance Recommendations

Recommendation I.352 – Network performance objectives for connection processing delays in an ISDN (revision planned)

Recommendation I.352 defines speed parameters and objectives for describing N-ISDN circuit mode access and disengagement performance. The parameters are defined on the basis of I.353 reference events. Key parameters are call set-up delay and call clearing delay. The parameters and objectives apply to specified portions of an international end-to-end circuit mode connection. This Recommendation provides a basis for N-ISDN circuit mode availability performance specified in Recommendation I.355.

Recommendation I.353 – Reference events for defining ISDN performance parameters (revision planned)

Recommendation I.353 defines the measurement points and performance-significant reference events that are used in Recommendations I.352, I.354, I.355, I.356, I.357, I.35bcp, and I.35D to define performance parameters for international ISDN services.

Recommendation I.354 – Network performance objectives for packet mode communication in an ISDN (1993)

Recommendation I.354 defines speed, accuracy, and dependability parameters and objectives for describing N-ISDN packet mode access, information transfer, and disengagement performance. The parameters are defined on the basis of I.353 reference events. Key parameters are call set-up delay, call set-up denial probability, errored packet ratio, packet loss ratio, and call clearing delay. The parameters and objectives apply to specified portions of an international end-to-end packet mode connection. This Recommendation provides a basis for N-ISDN packet mode availability performance specified in Recommendation I.355.

Recommendation I.355 – ISDN 64 kbit/s connection type availability performance (1995)

Recommendation I.355 defines parameters and objectives for describing N-ISDN circuit mode and packet mode availability performance. The circuit mode and packet mode parameters are defined on the basis of G.821, I.352, and I.354 parameter thresholds. Key parameters are percent service availability and mean time between service outages. The parameters and objectives apply to specified portions of international end-to-end N-ISDN circuit mode and packet mode connections.

Recommendation I.356 – B-ISDN ATM layer cell transfer performance (1996)

Recommendation I.356 defines speed, accuracy, and dependability parameters and objectives for describing B-ISDN ATM information transfer performance. The parameters are defined on the basis of I.353 reference events. The key parameters include cell transfer delay, cell delay variation, cell error ratio, cell loss ratio, and severely errored cell block ratio. It includes adjusted parameter definitions that might be used when cells do not conform with the negotiated traffic contract. The parameters and objectives apply to specified portions of an end-to-end international B-ISDN ATM connection. Parameter values are grouped together into different QOS classes that users may request on a connection-by-connection basis. This Recommendation provides a basis for B-ISDN ATM availability performance specification in Recommendation I.357.

Recommendation I.357 – B-ISDN semi-permanent connection availability (planned)

Recommendation I.357 defines parameters and (planned) objectives for describing B-ISDN ATM availability performance. The parameters are defined on the basis of I.356 parameter thresholds and apply to semi-permanent connections. Key parameters are availability ratio and mean time between outages. The parameters and (planned) objectives apply to specified portions of an international end-to-end B-ISDN ATM semi-permanent connection.

Recommendation I.35bcp – Call processing performance for a B-ISDN (planned)

Recommendation I.35bcp (draft) defines speed, accuracy, and dependability parameters and objectives for describing B-ISDN access and disengagement performance, including call processing functions supporting multipoint connections and the adding and dropping of parties. The parameters are defined on the basis of I.353 reference events and apply to specified portions of an end-to-end international B-ISDN connection. The key parameters are connection establishment delay, party establishment delay, connection release delay, party release delay, disconnect delay, party disconnect delay, and connection failure probability. The parameters and objectives apply to specified portions of an international end-to-end B-ISDN connection.

Recommendation I.35D – Accuracy and dependability of ISDN 64 kbit/s circuit mode connection types (planned)

Recommendation I.35D (draft) defines accuracy and dependability parameters for describing N-ISDN circuit mode access, information transfer, and disengagement performance. The parameters are defined on the basis of I.353 reference events. Key parameters are connection denial probability, incorrect call set-up probability, and premature disconnect probability. The parameters apply to specified portions of an international end-to-end 64 kbit/s circuit mode connection.

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