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**TELEPHONE NETWORK AND ISDN
QUALITY OF SERVICE, NETWORK MANAGEMENT
AND TRAFFIC ENGINEERING**

**GOS PARAMETERS AND TARGET
GOS OBJECTIVES FOR IN SERVICES**

ITU-T Recommendation E.724

(Previously "CCITT Recommendation")

FOREWORD

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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).

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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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SUMMARY

To ensure the effective deployment of Intelligent Network (IN) capabilities, performance objectives must be established to serve as a basis for traffic engineering and related network planning. This Recommendation defines performance parameters for a range of IN services and provides corresponding Grade of Service (GOS) performance objectives. Currently only one such objective, namely incremental post-selection delay is addressed.

For the successful introduction of new service capabilities provided by intelligent networks, network planning and engineering should be based on the fundamental requirement of providing acceptable service to the end user. Reasonable grade of service performance objectives have been developed by understanding user expectations and typical implementations of representative IN services.

The Recommendation introduces the notion of service classes that are defined on the basis of end user requirements.

Performance requirements during periods of network congestion are for further study.

GOS PARAMETERS AND TARGET GOS OBJECTIVES FOR IN SERVICES

(Geneva, 1996)

1 Scope

This Recommendation is limited in scope to cover Capability Set 1 (CS-1). Extensions to cover further evolution of IN concepts are for further study. Before using this Recommendation for applications other than CS-1, the user should check that it is appropriate to do so.

Appropriate performance objectives in the IN environment should carefully balance user expectations and technology capabilities. The latter are largely influenced by factors such as reference connections, signalling message flows, nodal processing times and queuing delays associated with particular service-deployment scenarios. Expectations of the end user in an IN environment are based on assessments of typical user tolerance to various delays and categories of unavailability - again for particular services or service classes.

2 References

The following Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated are valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of currently valid ITU-T Recommendations is regularly published.

Recommendations Q.1202, Q.1211, Q.1214, Q.1218, Q.1219, E.492, E.721, E.723, E.733, Q.706, Q.716 and Q.766.

3 Definitions

For the purposes of this Recommendation, the following definitions apply:

3.1 comparable call: A call which does not invoke IN services and which is selected by the network operator as being similar in user expectation, with respect to the post-selection delay, to the call(s) invoking the IN service(s) under consideration. Where there are no calls with similar user expectation, the network operator may select an average call as the comparable call.

3.2 incremental post-selection delay: This parameter is the increase in the post-selection delay (as defined in Recommendation E.721) when IN services are invoked on a call. For calls involving the setting up of voice connection paths beyond the usual expectation for a call type (for example, as the result of a call forwarding action triggered by the called number) the IN processing delay includes any extra delay in setting up such a path. Calculation of this value for calls involving a user interaction with the IN service logic is for further study.

3.3 IN services: Services implemented using IN structured networks.

4 Abbreviations

For the purposes of this Recommendation, the following abbreviations are used:

CPE	Customer Premises Equipment
CS-1	Capability Set 1
GOS	Grade of Service
IN	Intelligent Network
IP	Intelligent Peripheral
ISDN	Integrated Services Digital Network
SCP	Service Control Point
SDP	Service Data Point
SSP	Service Switching Point
STP	Signalling Transfer Point
UPT	Universal Personal Telecommunication

5 General

5.1 Intelligent network overview

In the development of this Recommendation, use has been made of the definitions of intelligent network concepts (including concepts relating to capability set 1) which are contained in the Q.1200-Series of Recommendations. In particular, Recommendations Q.1201, Q.1211, Q.1214, Q.1218 and Q.1219 are noted.

The intelligent network architecture is based primarily on a network concept for the support of supplementary services provided in combination with bearer services, teleservices, broadband interactive services and broadband distribution services. CS-1 services and features described in Recommendation Q.1214 have been analysed in establishing service categories and in determining the grade of service targets given in clause 8.

From the performance assessment standpoint, a service type will be characterized by the associated combination(s) of IN transactions and circuit and signalling connections involved in the invocation of the service.

5.2 Performance assessment methodology

The GOS targets of clause 8 have been determined based on background studies using network models incorporating representative services and features to provide information on achievable performance (as perceived by the end user) in typical intelligent network environments.

On the one hand, a bottom-up approach was used to assess end-to-end delays perceptible to end user by utilizing Recommendations in the E.700- and Q.700-Series [which contain delay objectives for signalling links, Signalling Transfer Points (STP), signalling relay points, Service Switching Points (SSP) and Service Control Points (SCP)] – in conjunction with appropriate reference connections (see clause 7). In particular, Recommendations E.723, E.733, Q.706, Q.716 and Q.766 have been used.

This bottom-up approach was complemented by a top-down assessment based on user performance expectations – which are discussed more fully in 6.3. In the former approach, distinct call types have differing associated topological reference connections; from the top-down perspective, they have differing user expectations.

Performance objectives for service switching points, signalling transfer points, service control points, Intelligent Peripherals (IP) and Service Data Points (SDP) are for further study.

6 Service analysis

6.1 General

This Recommendation can be viewed as extending Recommendation E.721, which takes into account only a limited penetration of IN services (such as the freephone and credit card calling services which require simple interaction with a database). With the increasing penetration of IN services that require database look-up for number translation and/or other call screening purposes, new reference connection models that include the database query-response aspects are needed (see clause 7).

6.2 Representative service definitions

As an example, Universal Personal Telecommunication (UPT) is an important application which will support a whole class of database-dependent services. UPT will be providing personal mobility management functions, and it is generally recognized that the evolving IN architecture is well suited for supporting these UPT functions. In this context, IN resource allocation will depend on optimizing the location of databases as part of overall UPT information-sharing strategies. UPT deployment in an IN environment therefore provides valuable insight into the broad issue of IN resource allocation and dimensioning and the consequent impact on performance parameters like post-selection delay and answer signal delay seen by the end user.

In addition to the UPT services just described, a range of CS-1 services and features have been examined.

(Further study is required to classify these services and features into categories which may need to be separately specified in clause 8.)

6.3 User-perceptible GOS criteria

In setting traffic standards for IN, the existing standards for basic telephony and Integrated Services Digital Network (ISDN) provide a useful structure, with extensions required to address the new network realities introduced with IN. The following subclauses discuss the issues which have led to the GOS criteria provided in clause 8.

6.3.1 Importance of post-selection delay

As switching technology has advanced, post-selection delays have decreased dramatically. With the wide deployment of SS No. 7, delays are less than with tone signalling and users come to expect quicker call setup. With the introduction of IN services, post-selection delays increase. Time is required to send and process the messages for service logic. If the delays become too long, users will become dissatisfied and may even believe that there has been some kind of network failure. Therefore, it is particularly important to set standards for post-selection delays in IN.

6.3.2 Separate network and service objectives

For a network operator, it is important to ensure that the service to the users achieves at least a certain minimum level of quality. Therefore, it is appropriate to establish a GOS standard for the average post-selection delay averaged over all calls in the network. With the intelligent network, any given call may invoke more than one IN service. The designer of an IN service may not be the network provider and hence the designer may not know the total network GOS level. To assist service design, standards should provide additional targets directed to the GOS of the specific service. Therefore, when possible, standards should provide GOS targets relevant to individual service classes, in addition to targets for total network GOS. Note also that there may be some services, such as non-call related messaging, for which individual-service GOS objectives are appropriate, yet these services will not be included in the GOS objectives for networks.

6.3.3 Target values

GOS standards may be defined for different purposes. Existing GOS standards have been selected, and networks engineered, to assure a network operator that performance is acceptable, considering the limitations imposed by technology. With the introduction of IN and with the rapidly evolving technology, it may be desirable, in some cases, to select more stringent design targets to provide a greater level of user satisfaction. In these situations, thresholds should identify the delay under which user satisfaction does not significantly increase. Clause 8 identifies, for service design and network planning purposes, the threshold of mean delays under which end user satisfaction does not significantly change.

6.3.4 User-based target

As IN services are introduced into the network, end users may not be aware of the new requirements for processing of the service logic. They may well be unaware that any IN service is invoked at all (for example, when a call is redirected to an alternate location to follow another user). Therefore, some limit is appropriate to minimize the total post-selection delay. Such a limit should be based on the end users' GOS requirements as typically established in a testing or trial environment. To provide GOS targets useful in designing a new service, reliance must be on testing data rather than on user experience with the actual service.

6.3.5 Incremental delay for processing IN services

Existing standards for regular telephony and ISDN provide a good basis for engineering even in IN structured networks. The extra complexity and performance issues in IN can be addressed with GOS targets specifying the appropriate additional requirements. Considering the discussion of the previous subclauses, it is useful to set objectives for the increment in post-selection delay attributable to the processing of IN services. This allows development of GOS targets for service classes and the forecasting of the total expected post-selection delay based on the expected mix of invoked services.

6.4 User expectation data

Data derived from laboratory investigation of users' expectation of post-selection delay has been used to derive the targets specified in clause 8. These results show that instead of a single GOS target, several different ones are required. The following subclauses outline the reasons for this.

6.4.1 Allowance for connection type

As reflected in Recommendation E.721, GOS objectives for ISDN, users will allow extra delay when calls are perceived to involve setup over a greater distance. The differentiation of Recommendation E.721, into local, toll and international connections, seems also to be appropriate in this Recommendation.

6.4.2 Allowance for new services or special calls

Users will allow extra delay when they recognize that the call involves extra processing (for example, a call to a cellular radio subscriber) or a new service. It appears that users will tolerate some extra delay, at least initially, but may come to expect quicker response as familiarity with the service builds. Further study is required to provide additional direction in setting GOS targets for such circumstances.

7 Reference topologies

The GOS objectives envisioned for this Recommendation represent the increases in post-selection delay attributable to the provision of IN services. Because more than one IN service may be invoked on a call, a distinction is made between the incremental delay of a single IN service and the total delay on a given call caused by all the IN services invoked.

For the purposes of 8.1 and 8.2, several topologies are relevant. In the discussion which follows, the following notation is used:

- D_T = Incremental post-selection delay for all services (see 8.1);
- D_S = Incremental delay for processing a single IN service (see 8.2).

For each topology, two delays are calculated:

- D_{IN} = Delay between specific points in the call setup for a call using one IN service (or more, as in reference topology 5); and
- D_N = Delay between the same points in the call setup for a comparable call which does not use IN services.

The delay D_N in this Recommendation represents a component of the total user-to-user post-selection delay specified in Recommendation E.721.

For the purposes of clause 8, then:

$$D_T \text{ (or } D_S) = D_{IN} - D_N$$

The following notes are relevant to the reference topologies:

- 1) These topologies are illustrative, rather than exhaustive in defining the relevant post-selection delays. The topologies are also functional, rather than necessarily representational. For example, queries are shown as going directly to Service Control Points (SCP) while they may, in fact, be routed through Signalling Transfer Points (STP). The queries may not even leave the SSP node if the SSP contains the necessary logical and database functionality to provide the service. In all cases, a signalling network is implied to support signalling between the IN components. For simplicity of description, these elements are not explicitly shown in these reference topologies, but the delays associated with these signalling functions are included, where appropriate, in the incremental delay calculation.
- 2) The “time to” reference in each topology is defined to be the most relevant (on a case-by-case basis) of the following:
 - time of arrival of the call at the next SSP (if it is to be further switched);
 - sending forward of the ISDN alerting message; or
 - return of audible response towards the call originator.

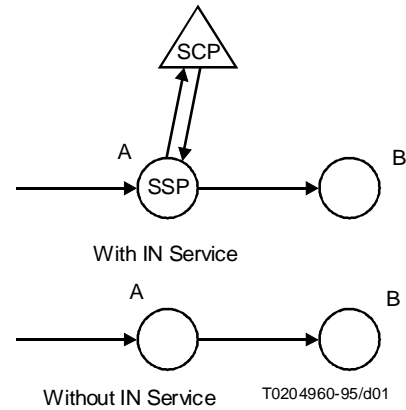
Note that when calculating the values of D_{IN} and D_N for a given topology, the “time to” reference points must be the same kind for both so that a true before/after comparison is made.

- 3) Where the following reference topologies indicate that a call will be switched to another SSP, the delay calculation for calls destined to terminate in the first SSP will be made in an analogous manner.
- 4) For a specific service, processing and call setup may follow different reference topologies depending on the specific logic and data processed during the setup of each call. To determine the mean delay for this service, a weighted average is determined for the various possible reference topologies.
- 5) For services which do not fit these topologies well, a calculation is made of the extra delay (or apparent delay), as experienced by the call originator, in the setting up of the desired call, as compared to a similar call which does not involve IN processing.
- 6) These topologies are not intended to represent the full call setup path. Rather, the intent is to identify for IN service calls only that portion of the delay in the setup path which differs from delay in the setup path on non-IN calls.
- 7) In the diagrams which follow, the circles represent exchanges which may be either local or transit exchanges. As used in these topologies the boxes marked “CPE” represent call termination equipment.
- 8) Arrows in these topologies represent events occurring during the call setup. They may be signalling, connection or audible events.

Reference topology 1: single IN service – database query

This is the simplest case. An example of this type of IN service is a number translation to determine the routing address. Note that for IN services terminating on a line in SSP A, the calculation is similar, except that the “time to” is measured to audible response to the call originator. Note also that the service may involve more than one query and more than one SCP.

Value	Time from	Time to
D_{IN}	Call arrival at A	Call arrival at B ^{a)}
D_N	Call arrival at A	Call arrival at B ^{a)}

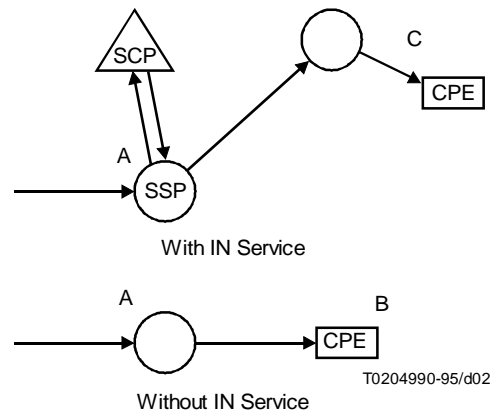


a) Call arrival at B, sending forward of ISDN alerting message or returning of audible response from A.

Reference topology 2: single IN service – call redirection

IN processing of a call may change the actual destination of the call. In this case the incremental delay includes not only the actual time to process the IN logic and database information, but also the time to setup the bearer path to the call destination.

Value	Time from	Time to
D_{IN}	Call arrival at A	ISDN alerting from C ^{a)}
D_N	Call arrival at A	ISDN alerting from A ^{a)}

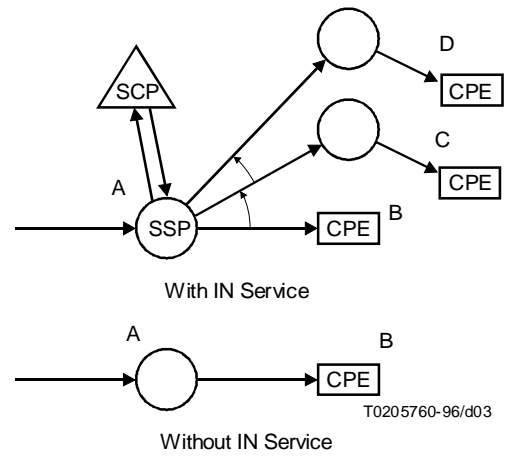


a) Sending forward of ISDN alerting message or returning of audible response.

Reference topology 3: single IN service – multiple setup attempts

IN services may involve complex call setup, potentially involving several sequential actions, before the calling party is notified of call progress. One example is the diversion of a call through a sequence of lines until the first idle line is found. A second example is the setting up of multiple simultaneous connections so that all may ring at once and the connection made to the first terminal that responds. In such cases, the IN service’s incremental post-selection delay is measured until the originating terminal is notified.

Value	Time from	Time to
D_{IN}	Call arrival at A	ISDN alerting from D ^{a)}
D_N	Call arrival at A	ISDN alerting from B ^{a)}



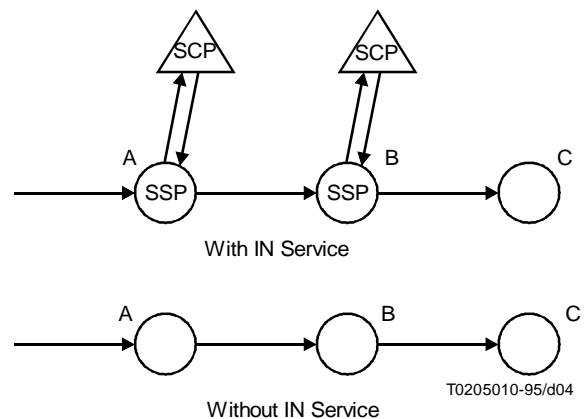
a) Sending forward of ISDN alerting message or returning of audible response.

Reference topology 4: multiple processing locations

Two cases may be considered:

- The user invokes only a single IN service, but a service may require processing at two different locations or may be composed of two or more IN capabilities. In this case the delay for the service must include the total delay for all processing.
- The user invokes more than one IN service which may be invoked on a single call. This incremental post-selection delay for processing all IN services (see 8.1) is the total delay caused by all services.

Value	Time from	Time to
D_{IN}	Call arrival at A	Call arrival at C ^{a)}
D_N	Call arrival at A	Call arrival at C ^{a)}

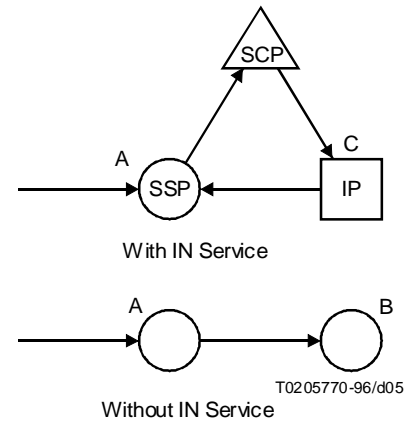


a) Call arrival at C, sending forward of ISDN alerting message or returning of audible response from B.

Reference topology 5: user interaction with the network

Certain IN services may involve the user's interaction with the network to accomplish some task. One example is the user registration process when the user is at a wireline terminal. By dialling appropriate codes, the user is connected to network resources with which the user interacts (for example, playing a recorded message or collecting user-entered digits). In this case, the incremental post-selection delay is calculated from a comparison with the typical delay to receive a network response to a comparable call.

Value	Time from	Time to
D_{IN}	Call arrival at A	Audible response from C
D_N	Call arrival at A	Audible response for comparable call



Reference topology 6: user interaction with the network before call completion

Certain IN services may involve the user's interacting with the network before the call is actually set up to the destination. Examples of this are requests to the user to dial extra digits giving a personal identification number, or of the playing of announcements, possibly with a request to make a selection among several choices. Such network topologies and target GOS objectives are for further study.

Reference topology 7: non-call related messaging

Certain IN services may include messaging which does not relate specifically to any call. One example is an automatic location updating request as a user moves across UPT domains without a call being in progress. Such network topologies and target GOS objectives are for further study.

In addition, there are other issues for further study. These issues include:

- "chaining" of SCP queries and databases connected to SCPs;
- the use of STPs in the international portion of the SS No. 7 network.

8 Target GOS objectives (provisional values)

The following subclauses provide GOS objectives for IN services and IN structured networks. Procedures to determine the appropriate reference periods for which these GOS targets apply and procedures for traffic engineering are under development within the E.700-Series of Recommendations, and Recommendation E.492.

In IN structured networks, the delays associated with call setup will be an important criteria of end user satisfaction. Subclauses 8.1 and 8.2 address the incremental delay for IN processing for networks and single services respectively. The tables in 8.1 and 8.2 also provide user threshold data calculated from a user study reported in [1]. The user study derived "zones" representing customer satisfaction with various call setup delays and the thresholds identified below are derived from the boundary above which users start to become dissatisfied (identified as the green-yellow boundary in [1]). In the case of the delay objectives for networks, network operators may apply this threshold so that 95% of all calls of a given type experience a delay less than the threshold. In examining the requirements for individual services, delay thresholds will have a strong dependence on the number and ratio of IN services active on users' calls. At this time, and for the purposes of service design requirements, a "green-yellow" delay threshold may only be derived for the mean of the incremental call setup delay for each service individually.

Evolution of IN services may define services which do not fit the network topologies outlined in clause 7. For calls involving such new services, the network and single service objectives below are for further study.

8.1 Delay objectives for networks

The following table gives the range of objectives for the processing of all IN services invoked on all calls of a given type. The type of connection (local, toll and international) is defined in Recommendation E.721.

Incremental post-selection delay for processing all IN services

Type	GOS Target		User Threshold (Note)
	Mean	99th Percentile	
Local connections	ffs ^{a)}	12 seconds	3.5 seconds
Toll connections	ffs	ffs	4.5 seconds
International connections	ffs	ffs	ffs

a) ffs: for further study.

NOTE – The numbers in this column represent the threshold under which end user satisfaction does not significantly change. This may be applied for service and network design purposes so that 95% of calls fall below this threshold delay.

8.2 Delay objectives for single services

The following table gives the range of service objectives for the processing of a single IN service. When multiple services are invoked in a call, the delay is assessed individually for each service.

Incremental delay for processing a single IN service

Service class	GOS Target		User Threshold (Note)
	Mean	99th Percentile	
1	4 seconds	ffs	1.5 seconds
2	ffs	ffs	ffs
3	ffs	ffs	1.0 seconds
4	ffs	ffs	ffs

Service Class 1 – Services, not otherwise specified, for which the caller is unaware that IN processing is required (for example, call forward).

Service Class 2 – Services, not otherwise specified, for which the caller is aware that extra processing is required (for example, if authentication of the caller is always performed on calls from that terminal equipment).

Service Class 3 – Freephone-type services.

Service Class 4 – Televoiting services.

NOTE – For service design and network planning purposes, the numbers in this column represent the threshold of mean delays under which end user satisfaction does not significantly change. This may be applied for service design purposes so that mean incremental delay falls below this threshold delay.

8.3 Blocking objectives for IN services

In general, all IN services are subject to blocking. Blocking objectives are for further study.

9 History

New Recommendation (1996).

Bibliography

- [1] MACDONALD (D.M.), ARCHAMBAULT (S.): Using customer perception in setting objectives for IN services, *ITC-14*, Antibes, Juan-les-Pins, 1994.