All drawings appearing in this Fascicle have been done in Autocad.

Recommendation Q.709

xe ""§HYPOTHETICAL SIGNALLING REFERENCE CONNECTION

1 Introduction

This Recommendation specifies how the elements of a signalling connection are combined to meet the signalling requirements of the networks that it supports. Included are parameters for signalling transfer delay in both national and international networks, and overall signalling delay that such combinations will produce, together with the availability required, to enable the performance of the network served by the signalling network to be maintained.

A probabilistic approach is been taken, i.e., limits are specified for mean and 95% of connections. These figures will apply to the normal operation of a signalling network. No consideration is given to the “unusually long” signalling paths that are found in some signalling networks. Any unusual routing caused by some network structures and/or reconfigurations due to network failure are considered to be covered in the remaining 5% of connections.

The hypothetical signalling reference connection (HSRC) for international working is specified in this Recommendation by defining the constituent parts of:

i) the international section,

ii) the national section.

In any combination of those sections to produce an overall hypothetical signalling reference connection, it is necessary to consider what impact each of the component parts (international and two national sections) have on each other and the full hypothetical signalling reference connection. This means that certain national or international limits such as the maximum number of signalling transfer points allowed in a signalling relation (see Recommendation Q.705, § 5.2) require modification and account of this has been taken in this Recommendation.

2 Requirements of networks served by the signalling connection

To meet the requirements of services carried on the network served by the signalling network, the signalling connection performance should be closely aligned with those requirements. Since these services are ultimately to be carried on an ISDN, the hypothetical signalling reference connection is based upon the hypothetical reference connection produced for that network (Recommendation G.801).

However, for a considerable time the majority of services in the network served by the signalling network will be telephony–based and account must therefore be taken of the reference connection for conventional telephony application (Recommendation G.101).

3 xe ""§Hypothetical signalling reference connection components for link–by–link signalling

3.1 *General*

The components of an hypothetical signalling reference connection are signalling points and STPs which are connected in series by signalling data links to produce a signalling connection (Note 1). The number of signalling points and STPs depend on the size of the network. Two limits are prescribed to cover mean or 95% cases. Separate cases are allowed for large countries and average sized countries (Note 2). This section outlines the considerations involved in formulating a hypothetical signalling reference connection for link–by–link signalling and details the number of hypothetical signalling reference connection components and the delays they produce.

Note 1 – The term signalling point is used to designate use of the user function in a signalling point: whether or not STP function is presented irrelevant in this context. The term STP is used to designate use of the STP function in a signalling point: whether or not user function is present is irrelevant in this context.

Note 2 – When the maximum distance between an international switching centre and a subscriber who can be reached from it does not exceed 1000 km or, exceptionally, 1500 km, and when the country has less than $n \times 107$ subscribers, the country is considered as of average size. A country with a larger distance between an international switching centre and a subscriber, or with more than $n \times 107$ subscribers, is considered as of large size. (The value of n is for further study.)

3.1.1 *Number of signalling points in the hypothetical signalling reference connection*

The number of signalling points in the hypothetical signalling reference connection has been determined by considering the maximum number of links allowed by the Telephone Routing Plan (Q.13/E.171). These Recommendations define “last choice” backbone routes and only a small proportion of traffic take these routes. Traffic generated in metropolitan areas, generally the largest source of traffic, usually takes far fewer links to an international switching centre. Even for rural areas a connection to the international switching centre will not generally be required to follow the backbone route.

Limitation of the number of signalling points required will reduce the signalling delay, considering that signalling point delay, forms the largest component of signalling delay.

3.1.2 *Number of STPs in an hypothetical signalling reference connection*

The number of STPs in the hypothetical signalling reference connection is a function of the number of signalling points, and the signalling network topology used to connect these signalling points. The number of STPs should be kept to a minimum in order to limit the signalling delay. In some signalling relationship, associated signalling may be used for which no STPs are required. In others, one or more STPs may be used. For international signalling relationship, it is recommended that no more than 2 STPs be used in a signalling relation. (See Recommendation Q.705, § 5.2.)

3.1.3 *xe ""§Signalling network availability*

The availability of a signalling connection is an important network parameter. It is necessary for the availability to be significantly better than the availability of the component being controlled (e.g. a circuit). A figure of 10 minutes down time per year maximum unavailability is recommended for any particular signalling route set (Recommendation Q.706, § 1.1).

This corresponds to an availability of 0.99998, which can be achieved by the use of suitable network redundancies.

3.1.4 *xe ""§Signalling message transfer delay*

Signalling message transfer delay is another important network parameter. It affects call set up delay and also affects network response time to service requests made during a call. In this Recommendation, the transmission propagation delays are not included (see § 7.2).

3.2 *International component of hypothetical signalling reference connection*

The international component of the hypothetical signalling reference connection includes all international signalling points in the connection and the STPs carrying signalling messages between the signalling points. The maximum number of signalling points and STPs allowed are listed in Table 1/Q.709.

The unavailability of the overall international component of the signalling network should not exceed the following totals per year for both the 50 and 95 percent cases.

– 20 minutes for large country to large country,

– 30 minutes for large country to average–sized country, and

– 40 minutes per year for average–sized country to average–sized country.

TABLE 1/Q.709

Maximum number of signalling points and STPs in international component

Country size (Note)	Percent of connections	Number of STPs	Number of signalling points
Large to Large	mean	3	4
	95	4	3
Large to Average–sized	mean	4	
	95		

4

4

Average–sized
to
Average–sized

mean

95
5

7

5

Note See Note 2 to § 3.1.

The maximum signalling transfer delay under normal conditions for the international component of a connection should not be worse than the values listed in Table 2/Q.709.

3.3 *National components of hypothetical signalling reference connection*

The national components of the hypothetical signalling reference connection includes all national exchanges in the connection (but does not include the international switching centre in the country) and all STPs carrying signalling messages between the national exchanges and between the highest level national exchange and the international switching centre. The maximum number of signalling points and STPs allowed are listed in Table 3/Q.709.

TABLE 2/Q.709

Maximum signalling delays for international component

Delay (Note) (ms)

Country size

Percent of connections

Message type

	Simple (e.g. answer)	Processing intensive (e.g. IAM)
Large to Large		
	mean	
	95	
	390	
	410	
	600	
	620	
Large to Average–sized		
	mean	
	95	
	520	
	540	
	800	
	820	
Average–sized to Average–sized		
	mean	
	95	
	650	

690
1000

1040

Note – Only the mean delay component from Table 4/Q.706, Table 3/Q.725 and Table 1/Q.766 have been used in calculating the delay. Further study is required, e.g. for the mean values as well as the inclusion of overload and/or 95 percentile cases of each component value.

TABLE 3/Q.709

Maximum number of signalling points and STPs in national components

Country size (Note 1)	Percent of connections	Number of STPs	Number of signalling points
Large	mean	3	3
	95	4	4
Average–sized	mean	2	2
	95	3	

Note 1 – See Note 2 to § 3.1.
Note 2 – The values in this Table are provisional. (A higher number of signalling points and/or STPs might be included in a national network, e.g. in the case that a two–level hierarchical signalling network is adopted. This matter is for further study.)

The unavailability of each of the overall national components of the signalling network should not exceed the following totals per year:

– 20 minutes for mean case of average–sized countries,

– 30 minutes for 95 percent case of average–sized countries and mean case of large countries, and

– 40 minutes for 95 percent case of large countries.

Note 1 – Although the signalling component of the international switching centre in the country was not included in Table 3/Q.709, it is included in the unavailability objectives.

Note 2 – The hypothetical signalling reference connection define a unique path through the national and international networks, therefore when considering the overall unavailability of each national component, no account is taken of any standby path, if provided, in that national network. The values given are based on those for each component route–set as specified in Recommendation Q.706, § 1.1. They are provisional and for further study.

The maximum signalling transfer delay under normal conditions for each of the national components of a connection should not be worse than the values listed in Table 4/Q.709.

TABLE 4/Q.709

Maximum signalling delays for each national component

Delay (Notes 1 and 2) (ms)

Country size
Percent of connections
Message type

	Simple (e.g. answer)	Processing intensive (e.g. IAM)
Large		
mean	95	390
	520	600
	800	
Average–sized		
mean	95	260
	390	400
	600	

Note 1 – See Note to Table 2/Q.709.
Note 2 – The delay does not include any delay for the International Switching Centre in the country, which is included in the international component.

4 xe ""§Overall signalling delay for link–by–link signalling

From the hypothetical signalling reference connection and the values of message transfer times given for signalling point and STP, the overall signalling delay due to signalling point, and STP delays can be determined from Tables 2 and 4 of this Recommendation, for a given load in a given network. Average delays and 95 percentile delays are given in Table 5/Q.709 for various combinations of large and average–sized countries. Average signalling point and STP delays at normal loading are assumed.

These values must be increased by the transmission propagation delays (see Table 1/Q.41).

TABLE 5/Q.709

Maximum overall signalling delays

Country size Percent of connections Message type	Delay (Note) (ms)
Large to Large Simple (e.g. answer)	mean 95 1170

		1450
		1800
		2220
Large to Average–sized		
	mean	
	95	
	1170	
	1450	
	1800	
	2220	
Average to Average–sized		
	mean	
	95	
	1170	
	1470	
	1800	
	2240	

Note – See Note to Table 2/Q.709.

5 xe ""§Hypothetical signalling reference connection (HSRC) components for end–to–end signalling

5.1 *General*

The components of a hypothetical signalling reference connection are signalling end

points (SEP), signalling points with SCCP relay function (SPR) and STPs which are connected in series by signalling data links to produce an end–to–end signalling connection (Note 1). The number of the various signalling nodes depends on the size of the network. Two limits are prescribed to cover mean or 95% cases. Separate cases are allowed for large countries and average–sized countries (Note 2). This section outlines the considerations involved in formulating a hypothetical signalling reference connection and details the number of hypothetical signalling reference connection components and the delays they produce.

Note 1 – a)
part/application part), SCCP (Signalling connection control part), MTP (Message transfer part) and also MTP–SCCP–UP/AP

b) Signalling Point with SCCP relay function (SPR) – This includes only processing in MTP–SCCP–MTP

c)

Note 2 – When the maximum distance between an international switching centre and a subscriber who can be reached from it does not exceed 1000 km or, exceptionally, 1500 km, and when the country has less than $n \times 107$ subscribers, the country is considered as of average size. A country with a larger distance between an international switching centre and a subscriber, or with more than $n \times 107$ subscribers is considered as of large size. (The value of n is for further study.)

5.1.1 *Number of signalling nodes in the end–to–end HSRC*

The same signalling network is used for end–to–end messages and link–by–link messages. This means that the maximum number of signalling nodes is equal in both cases. The maximum number of signalling nodes from the originating node to the destination node is 18 in 50 percent of the connections and 23 in 95 percent of the connections except for average–sized to average–sized country. In that case the value is 24.

In general a fast transfer of end–to–end signalling messages has to be required. For such messages a route with a minimum number of signalling transfer and relay points is highly desirable.

It is desirable to use the message routing of the MTP (STP functions) as far as possible and trying in this way to avoid processing in higher layers (SCCP or user functions).

5.1.2 *Signalling network availability*

The availability of a signalling connection is an important network parameter. It is necessary for the availability to be significantly better than the availability of the component being controlled (e.g. a circuit). A figure of ten minutes down time per year maximum unavailability is recommended for any particular signalling route set (Recommendation Q.706, § 1.1).

This corresponds to an availability of 0.99998, which can be achieved by the use of suitable network redundancies.

5.1.3 *Signalling message transfer delay*

Signalling message transfer delay is another important network parameter. It affects call set up delay and also affects network response time to service requests made during a call.

The use of signalling points with SCCP relay functions (SPR) should be kept to a minimum. In an SPR additional processing is performed which causes an additional delay, for example address translation for CR or UDT message types (processing intensive messages) or a local reference message mapping for CC or DT messages (processing simple message types). The cross office transit time for SPR is defined in Q.716. The cross–office transit time for an SEP is equal to *Tcu* in Q.766 or Q.725 and for an STP is equal to *Tcs* in Q.706.

5.2 *International component of hypothetical signalling reference connection*

The international component of the hypothetical signalling reference connection includes all international signalling nodes (e.g. SPR and STP) in the connection. The maximum number of SPRs and STPs allowed are listed in Table 6/Q.709.

TABLE 6/Q.709

Maximum number of SPRs and STPs in international component

Country size	Percent of connections	Number of STPs	Number of SPRs
Large to Large	mean	4	3
	95	4	2

Large
to
Average–sized

mean

95

6

6

2

3

Average–sized
to
Average–sized

mean

95

8

8

2

4

The unavailability of the overall international component of the signalling network should not exceed the following totals per year for both the 50 and 95 percent cases:

– 20 minutes for large country to large country;
– 30 minutes for large country to average–sized country, and
– 40 minutes per year for average–sized country to average–sized country.

The maximum delay at the signalling nodes under normal conditions for the international component of a connection should not be worse than the values listed in Table 7/Q.709.

TABLE 7/Q.709

Maximum delay at the signalling nodes for international component

Delay (ms)

Country size
Percent of connections
Message type

Processing simple
Processing intensive

Large
to
Large

mean

95
300

410
440

620

Large
to
Average–sized

mean

95
340

450
480

660

Average–sized
to
Average–sized

mean

95
380

600
520

880

Note 1 – The maximum signalling nodes delay is the sum of all cross–office delays involved.
Note 2 – All values are provisional.

5.3 *National components of hypothetical signalling reference connections*

The national components of the hypothetical signalling reference connection includes all national signalling nodes (e.g., SEP, SPR, STP) in the connection (but does not include the international switching centre in the country). The maximum number of SEPs, SPRs and STPs allowed are listed in Table 8/Q.709.

The unavailability of each of the overall national components of the signalling network should not exceed the following totals per year:

– 20 minutes for mean case of average–sized countries;
– 30 minutes for 95 percent case of average–sized countries and mean case of large countries, and
– 40 minutes for 95 percent case of large countries.

TABLE 8/Q.709

Maximum number of SEPs, SPRs and STPs in national component

Country size

Percent of connections

Number of
STPs

Number pf
SPRs

Number of SEPs	
Large	
	mean
	95
	4
	5
	1
	2
	1
	1
Average–sized	
	mean
	95
	2
	4
	1
	1
	1
	1

Note 1 – Although the signalling component of the international switching centre in the country is not included in Table 8/Q.709, it is included in the unavailability objectives.

Note 2 – The hypothetical signalling reference connection defines a unique path through the national and international networks, therefore when considering the overall unavailability of each national component, no account is taken of any standby path, if provided, in that national network. The values given are based on those for each component route–set as specified in Recommendation Q.706, § 1.1.

The maximum delay at the signalling nodes under normal conditions for each of the

national components of a connection should not be worse than the values listed in Table 9/Q.709.

TABLE 9/Q.709

Maximum delay at the signalling nodes for each national component

Country size Percent of connections Message type	Delay (ms)	
	Processing simple	Processing intensive
Large		
	mean	
	95	
	300	
		430
		440
		640
Average–sized		
	mean	
	95	
	260	
		300

400

440

Note 1 – The maximum signalling nodes delay is the sum of all cross–office delays involved.
Note 2 – All values are provisional.

6 xe ""§Overall signalling delay for end–to–end signalling

The link–by–link signalling delay is applicable where messages are processed by each signalling point (e.g. during call establishment). The use of end–to–end signalling intended to reduce the overall signalling delay.

From the hypothetical signalling reference connection and the values of message transfer times given for SEPs, SPRs and STPs, the overall signalling delay due to the node delays can be determined from Tables 7 and 9 of this Recommendation, for a given load in a given network. Average delays and 95 percentile delays are given in Table 10/Q.709 for various combinations of large and average–sized countries. Average signalling node delays at normal loading are assumed.

TABLE 10/Q.709
Maximum overall delay at the signalling nodes

Delay (ms)

Country size
Percent of connections
Message type

Processing simple
Processing intensive

Large

to
Large

mean

95
900

1270
1320

1900

Large
to
Average–sized

mean

95
900

1180
1320

1740

Average–sized
to
Average–sized

mean

95
9000

1200
1320

1760

Note 1 – The maximum signalling nodes delay is the sum of all cross–office delays involved.
Note 2 – All values are provisional.

7 Remarks

7.1 The above values for signalling delays assumes a message length distribution as given in Table 2/Q.706 and Table 2/Q.725, with a mean message length of 15 octets. However, a message length of e.g. 128 octets for SCCP user data in CR and CC messages and 255 octets for SCCP user data in DT messages are permissible. For such a message length the transmission time at 64 kbit/s is, in each signalling node, about 15 ms (128 octets) to 30 ms (255 octets) longer.

7.2 When defining an overall signalling delay the propagation delay must be included. This delay cannot be completely neglected due to the geographical size of the HSRC (see Table 1/Q.41).