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ITU Recommendations and QoS parameters related to Signalling Network design

5.4a

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Summary of ITU Recommendations and QoS parameters to be utilized for Signalling Network design

The following information and considerations are based on ITU-T Recommendations E.721 ed E.723

	Local	Toll	International
Number of Switching nodes (SP) from user plane	4	7	10
Number of STP for reference connections	3	8 (a)	12 (b)
Mean values for IAM end-to-end delay (sec.) for reference connections	0.9	2.3	4.0
Mean values for ANM delay (sec) for reference connections	0.75	1.50	2.50

a The number of STP's in the reference connection is obtained by assuming that one STP exists between each pair of signalling points (exchanges), and that two additional STP's exist somewhere in the reference connection. A variety of arrangements of STP's within the reference connection having the same number of STP's are possible.

b) In addition to a), one additional STP exists somewhere in the international part of the reference connection. It is also assumed that one of the signalling links is via satellite.

Partitioning GOS for signalling message delays

The total IAM delay of 4.0 seconds and ANM delay of 2.5 seconds should be partitioned between the national and international portions of the S.S. No. 7 network as follow:

Partitioning of IAM and ANM delays into national and international portions

	Total delay	International delay	National delay a)
IAM	4.0	1.5	2.5
ANM	2.5	1.0	1.5

a) The national portion must be allocated to the originating call portion and terminating call portion. In general, this allocation should be equal unless bilaterally agreed otherwise.

Unavailability of signalling relation

- **10 minutes/year (ITU-T Recommendation Q.706)**

Method to calculate the Signalling Traffic between to Signalling Points of the Network

a) Required parameters for network dimensioning

Signalling Traffic to be handled by a Signalling Link Set (Asig in MSU/s).

In case of associated mode of signalling this value can be derived from the traffic load on the trunks to be controlled by the signalling set.
This corresponds to a calculation based on normal working conditions.
In case of failures of some others link sets , the correspondent signalling traffic is distributed via alternative routes/link sets which will be loaded additionally.
In this case, during the calculation related to these link sets , the additional signalling traffic (Asig+), shall also to be taken into account

The parameter A (erlang) is found by multiplying the number of speech circuits **(Nc)** by the mean charge taken into account for each speech circuit **Tc (0.6 – 0.8 erlang). To design a network for further development 0.8 is recommended**.

b) Method to calculate the number of the Links/Link Set (Nlinks)

A = Nc x Tc (Traffic in erlang)

Asig = (A/tm) x Nmsu (Signalling traffic in MSU/s)

Nlinks = Asig x Lmsu / (Nl x Tr) (number of links per link set)

Nominal load on one Signalling Link at normal working conditions: Nl

- **Normal condition: Nl (tipically 20% , 0.2 erlang)**

Maximum load on one Signalling Link in case of failure conditions: Ml=40%

- **Fault conditions: Ml (tipically 0.4 erlang , additional factor Of = 1.3)**

Nlinks = Asig x 1.3 x Lmsu / (Ml x Tr) (links in case of fault)

Parameters to be taken into account for Signalling Network Planning

A: Traffic voice/data (erlang)

Asig: Signalling traffic related to A (erlang)

Nc: Number of Circuits per Signalling Relation

Tc: Traffic Load on trunks to be controlled by the Signalling link

Nmsu : Average quantity of Message Signalling Unit (MSU) transmitted via the Signalling channels for one representative call

Tr: Transmission bit rate of the Signalling link

Nl : Nominal load on one Signalling Link at normal working conditions

Lmsu : Average length of the MSU.

tm : Mean Holding time of the representative call

Example of Calculation of the number of Signalling Links

Example: Nc = 2360 between two SP's

Tc = 0,8

Nmsu= 6 (3+3)

Tr = 64.000 bps

Nl = 0,2 (20%)

Lmsu = 184 bits (23 byte average value)

t_m = 90 sec

1) Normal conditions

A = 2360 x 0.8 = 1888 erlang (Total traffic)

Asig = (1888 / 90) x 6 = 126 MSU/s (Signalling traffic)

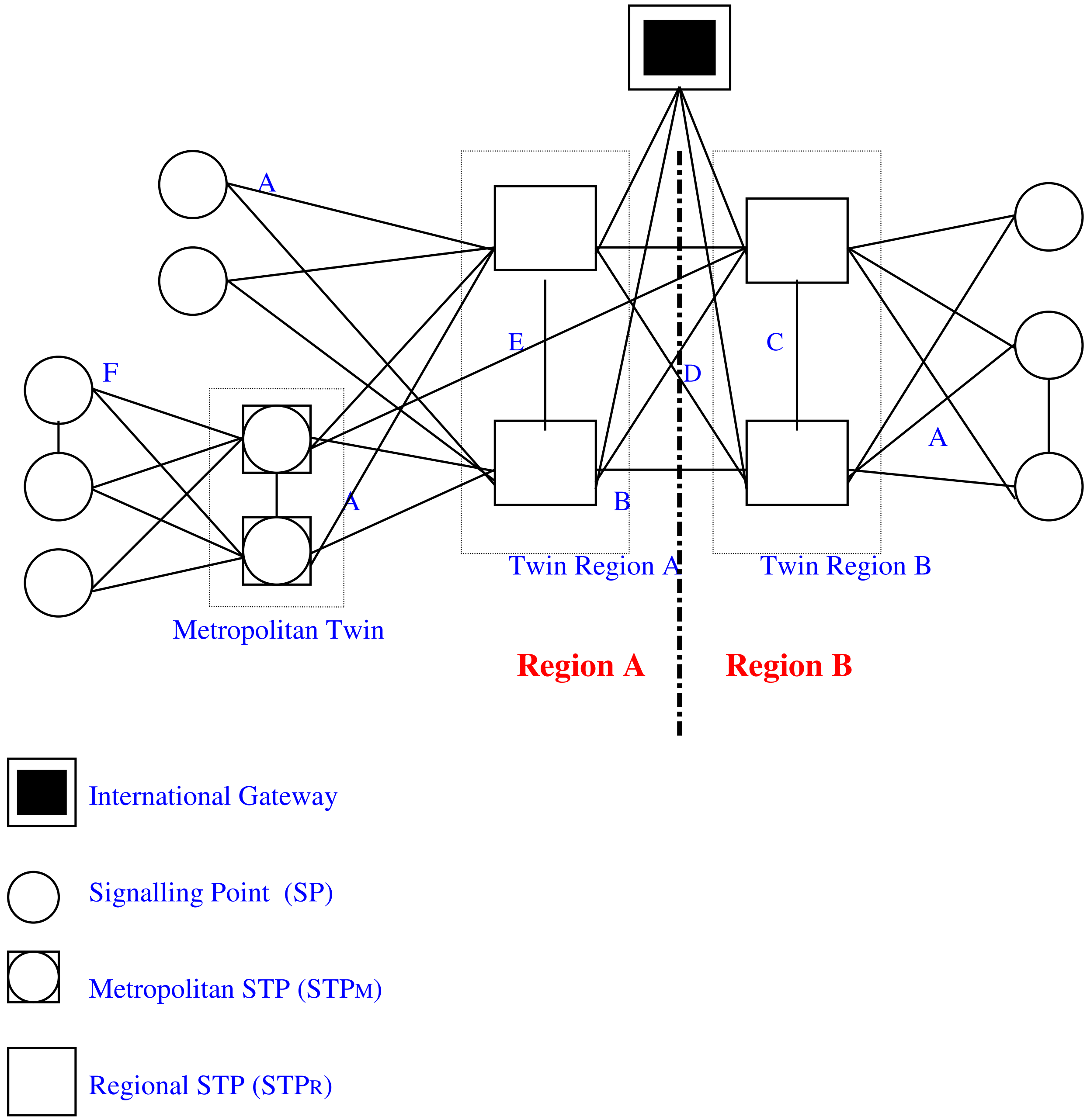
Nlink = 126 x 184 / (0.2 x 64000) = 1.8 (number of links**)**

2) In case of damage/Failure conditions

Nlinks = 126 x 1.3 x 184 / (0.4 x 64000) = 1.2 (links in case of damage)

The higher value is taken into account for network design.

Basic structure of Signalling Network based on two STP's Hierarchical Levels



Typical values of Unavailability of network elements

Unavailability of SP/STP = **2 min/ year**

Unavailability of transmission means I: **I = A+BxL**

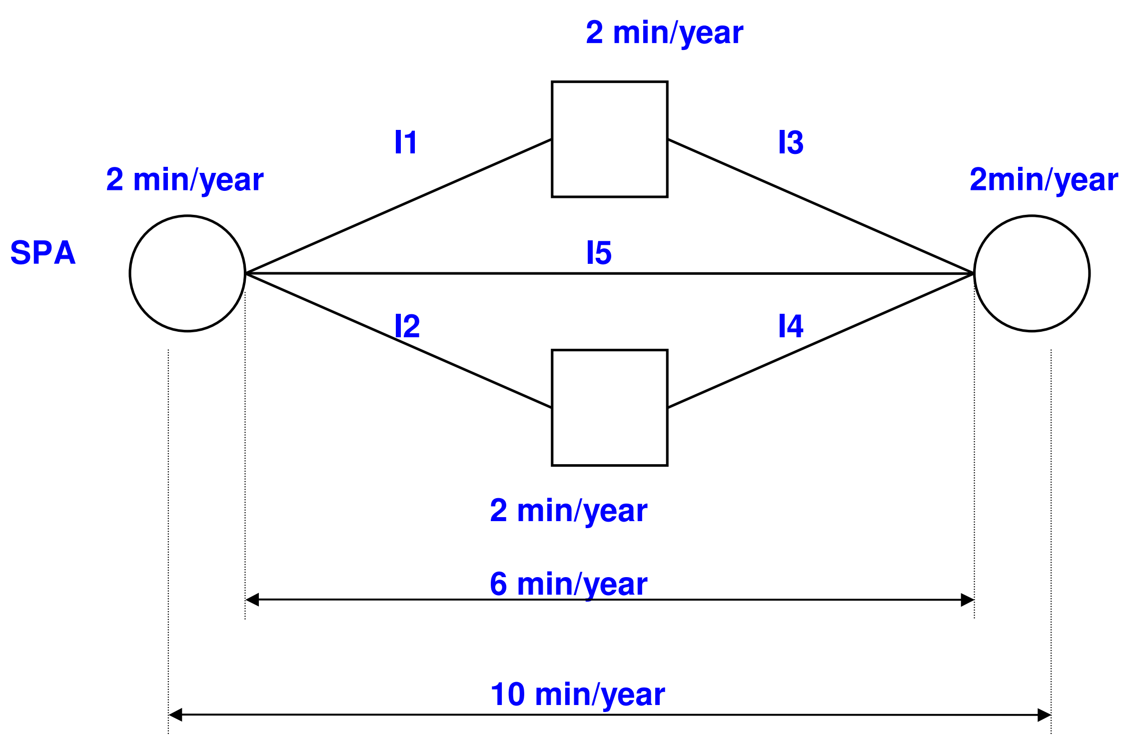
A: Unavailability of the transmission terminals
B: Unavailability of cable and regenerators / Km
L: Lengths (Km) of the transmission means

A and B depend on the type of the transmission means

A = 0.2 E - 4	**B = 0.42 E - 4**	**2 Mbit/s cable**
A = 2 E - 4	**B = 0.22 E - 4**	**8 Mbit/s cable**
A = 2.5 E - 4	**B = 0**	**Radio bridge**

For example for a cable of 25 Km , 2 Mbit/s :

I = 0.001 (525 min/year).



I1 - I5: Unavailability of signalling links

Example of Project of Signalling Network expansion for a Rural Area

Urban Area: Traffic 0.1 Erlang
Rural Area: 0.08 Erlang
Public Telephone: 0.8 Erlang

ASUNCIÓN - VILLA HAYES:	510 circuits (trunks)
ASUNCIÓN - FILADELFIA:	660 circuits
FILADELFIA - VILLA HAYES:	150 circuits
FILADELFIA - LOMA PLATA:	240 circuits
FILADELFIA - BENJAMIN ACEVAL:	330 circuits

CALCULATION OF SIGNALLING LINKS PER LINK SET

Generic initial Parameters:

Nc: Number of Circuits per Signalling Relation

Tc: Traffic Load on trunks (voice/data) to be controlled by the Signalling link

Tc = 0,8

Nmsu : Average quantity of Message Signalling Unit (MSU) transmitted via the Signalling channels for one representative call

Nmsu= 6

Tr: Transmission bit rate of the Signalling link

Tr = 64.000 bps

Nl : Nominal load on one Signalling Link at normal working conditions

Nl = 0,2 (20%)

Lmsu : Average length of the MSU.

Lmsu = 184 bits (23 byte average value)

tm : Mean Holding time of the representative call

t_m = 90 sec

- **Link Set ASUNCIÓN-VILLA HAYES**.

Nc = 510 circuits

1) A (voice traffic) = Nc x Tc = 510 x 0,8 = 408 Erl.

2) Asig (Signalling traffic) = (A x Nmsu)/ t_m = (408 x 6) / 90 = **27,2 MSU/s.**

3) Asig (Erl.) = (Asig (MSU/s) x Lmsu) / Tr = (27,2 x 180) / 64000 = **76,5 mErl**

4) Nlink (Number of signalling Links per Link Set)

Nlink = (Asig x Lmsu) / (Nl x Tr) = (27,2 x 184) / (0,2 x 64000) = 0,39 **1 link**

Using these formulas it is possible to calculate the number of circuits (trunks) to be handled by a single signalling link charged with 0.2 erlang of signalling traffic. The result is about **1300 circuits**.

5) In case of failures some Signalling Link Sets may be blocked and the corresponding signalling Traffic is distributed via predetermined alternative routes (Link Sets) which will be loaded additionally. For security reasons in case of failures the normal signalling traffic Asig is multiplied by 1.3.

In addition the **Nominal load on one Signalling Link (Nl) is considered to be 0.4 erlang.**

The number of Signalling Links per Link Set is calculated again with these two new values.

The higher value will be chosen to be able to face both normal and failure condition.

Nlink = (**1,3** x 27,2 x 184) / (**0,4** x 64000) = 0,25 **1 link**

- **Link Set ASUNCIÓN-FILADELFIA.**

Nc = 660 circuits

1) A = 660 x 0,8 = 528 Erl.

2) Asig = (528 x 6) / 90 = **35,2 MSU/s**

3) Asig (Erl.) = (35,2 x 185) / 64000 = **101 mErl.**

4) **1 link.**

- **Link Set VILLA HAYES-FILADELFIA.**

Nc = 150 circuits

1) A = 150 x 0,8 = 120 Erl.

2) Asig = (120 x 6) / 90 = **8 MSU/s**

3) Asig (Erl.) = (8 x 185) / 64000 = **23 mErl.**

4) **1 link .**

- **link Set VILLA HAYES-B.ACEVAL.**

Nc = 330 circuits.

1) A = 330 x 0,8 = 264 Erl.

2) Asig = (264 x 6) / 90 = **17,6 MSU/s**

3) Asig (Erl.) = (17,6 x 184) / 64000 = **50,6 mErl.**

4) **1 link.**

- **Link Set FILADELFIA-LOMA PLATA.**

Nc = 240 circuits

1) A = 240 x 0,8 = 192 Erl.

2) Asig = (192 x 6) / 90 = **12,8 MSU/s**

3) Asig (Erl.) = (12,8 x 184) / 64000 = **37 mErl.**

4) **1 link**

Signalling Traffic to be handled by each Signalling Point

ASUNCIÓN (increment) = 27,2 + 35,2 = **62,4 MSU/s**

VILLA HAYES = 27,2 + 17,6 + 8 = **52,8 MSU/s**

BENJAMIN ACEVAL = **17,6 MSU/s**

FILADELFIA = 35,2 + 8 + 12,8 = **56 MSU/s**

LOMA PLATA = **12,8 MSU/s**

CALCULATION OF SIGNALLING DELAYS

Typical situations are taken into consideration: Local connections, Toll connections (Rural area connected with Metropolitan area of Asunción), International interconnections (Ciudad del Este connected with the International gateway in Asunción).

Typical values of the Signalling Message Delays

- **Signalling Message Emission Time** = (No bits per MSU) / (Transmission speed)

  = 184 / 64000 = 2,875 ms.

- **Signalling Message Processing Time** = 5 ms.

  TOTAL= 5 + 2,875 = 7,875 == 10 ms. (considering an additional Queue delay)

- **Signalling Message Queue Delay** = 5 ms (between 1 a 5 ms)

- **Signalling Message Propagation Time** = 200 Km : 0,6 ms

  1000Km : 3,33 ms

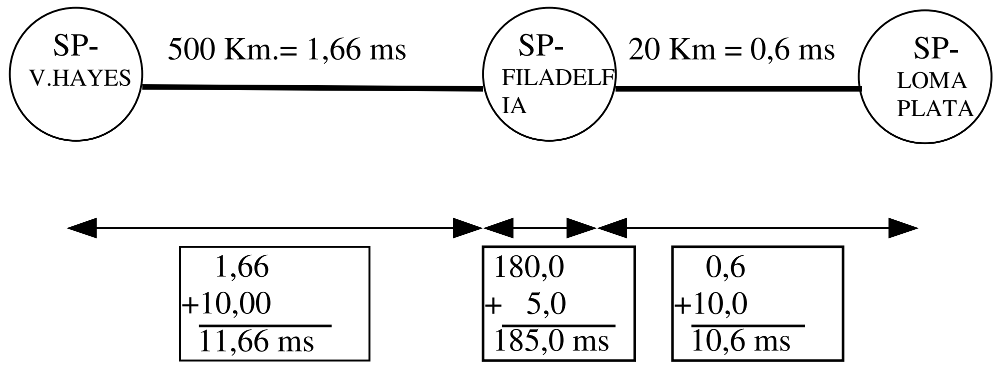
  2000 - 3000 Km: 10 ms.

- **Signalling Message Handling Time** = STP: 20 ms.

  SP: 110/180 ms (Cross Office Transfer Time)

First case (Local connection):

VALUE RECOMMENDED BY UIT-T REC. E.723: 750 -900 ms.

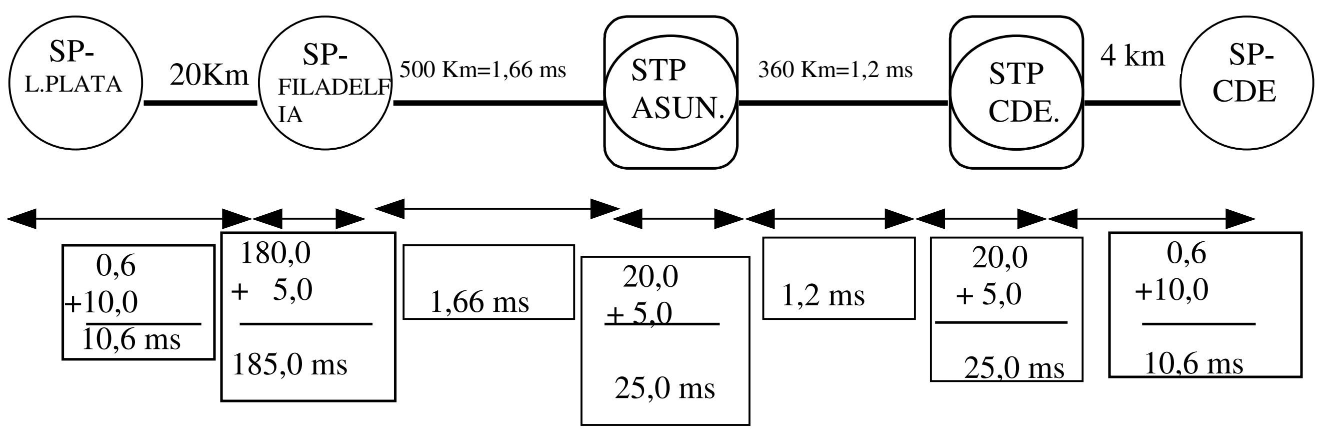


TOTAL= 11,66+185,0+10,6 = 207,26 ms.

Delay inside the recommended range

Second case (Tool connection – worst case):

VALUE RECOMMENDED BY UIT-T REC. E.723: 1500 a 2300 ms



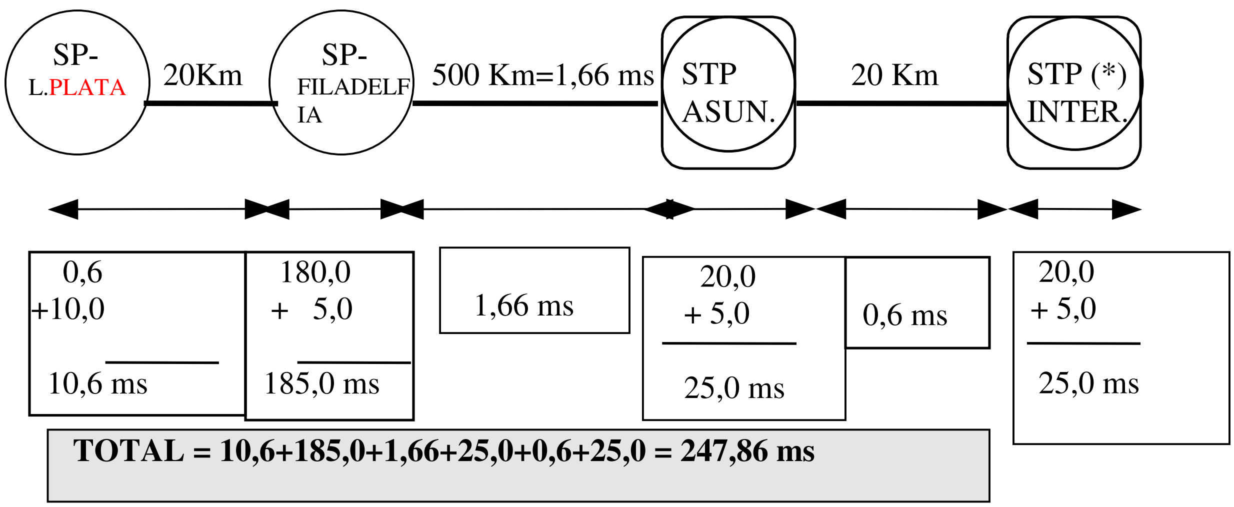
TOTAL = 10,6+185,0+1,66+25,0+1,2+25,0+10,6 = 259,06 ms

Delay inside the recommended range

Third case: (International connection)

VALUE RECOMMENDED BY UIT-T   REC. E.723: 2500 a 4000 ms.

The total delay should be shared (50%) by the two countries are involved in the international connection



Delay inside the recommended range

(*)The processing time is considered as 180 ms for International Gateway having SP function

It is necessary to verify the additional charge for the STP of **Asunción remains inside the allowable elaboration capability** A

Additional charge:

Link :

FILADELFIA- ASUNCIÓN	35.72 MSU/s
VILLA HAYES - ASUNCIÓN	27.2 MSU/s
	62.92 MSU/s

Value that can be managed by the STP in Asunción Capacity 1500 MSU/s.

The charge of each SP/STP should be verified each time new components are added in the Signalling network by taking into account the routing table matrix of the Signalling Network.
In addition, the unavailability values of the new signalling relations should be verified as well.