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

Recommendation E.523

STANDARD TRAFFIC PROFILES FOR INTERNATIONAL TRAFFIC STREAMS

The worldwide nature of the international telephone network, spanning as it does all possible time zones, has stimulated studies of the traffic streams between countries in different relative time locations. These studies have led to the development of standardized 24—hour traffic profiles which, theoretically based and verified by measurements, would be useful for engineering purposes. In fact, these concepts can be applied to a variety of network situations:

i) variable access satellite working where a large number of traffic streams with possibly differing traffic profiles share the pool of satellite circuits;

ii) combining of traffic streams on groups of terrestrial circuits which may be either high—usage or final choice routes;

iii) detour routing of traffic between origin and destination countries to take advantage of prevailing low load conditions on the detour path.

In developing any such applications, account must be taken of the International Routing Plan (Recommendation E.171 [1]) and of accepted accounting principles (Recommendation D.150 [2]).

It must be recognized that the preferred basis for dimensioning consists of traffic profiles based on real traffic. Nevertheless, many countries have found the standard profiles presented in this Recommendation very useful where streams are too small to obtain reliable measurements or where no measurements are available.

For both—way profiles, two equivalent methods of presentation are given in chart and tabular form. In Figure 1/E.523 hour—by—hour traffic volumes are shown in diagrammatically as percentages of the total daily traffic volume; such percentages are particularly convenient for tariff studies. In Table 1/E.523, hourly traffics are expressed as percentages of the busy hour traffic, and this is convenient for engineering purposes. Time zone differences are given in whole hours only. Directional profiles are given in Tables 2/E.523 and 3/E.523.

Although tables are given for both—way and directional traffic streams, it must be emphasized that at this stage only the both—way profiles can be regarded as soundly supported by measurement. The directional profiles are theoretically based and supported by some measurements, but should be used with caution until adequate verification has been achieved.

The theoretical basis for the profiles presented here is contained in Annex A. It depends on a convenience function $f(t)$ which represents the profile of local daily traffic, where of course no time zone difference exists. The function $f(t)$ used for computation of the standard profile was derived by mathematical manipulation of measurements of the Tokyo—Oakland and Tokyo—Vancouver streams. Although these results have been supported by other measurements, it leaves open the possibility that the convenience function may vary from one country to another and that, strictly, these should be derived independently and then used to obtain a calculated profile for the international relation. It also seems that the convenience function for the country of destination should be given greater weight than that for the country of origin. These remarks suggest possible refinements, but are not quantified in this Recommendation.

Figure 1/E.523 - CCITT 48101

TABLE 1/E.523

Standard hourly bothway traffic patterns

Local time in the more westerly country

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	BH %
0	5	5	5	5	5	5	10	10	50	90	100	95	85	70	85	85	70	45	25	40	40	35	20	15	10.0
1	5	5	5	5	5	5	10	25	70	95	100	90	80	80	85	80	60	35	30	40	35	25	15	10	10.0
2	5	5	5	5	5	5	20	30	75	100	100	90	90	85	85	65	45	45	35	40	30	25	15	5	10.0
3	5	5	5	5	5	5	25	35	75	100	95	100	95	80	70	50	60	45	35	30	25	15	5	5	10.4
4	5	5	5	5	5	5	25	35	65	85	100	100	85	60	50	60	55	40	25	25	20	5	5	5	11.5
5	5	5	5	5	5	5	25	30	65	95	100	90	70	50	60	60	55	30	20	20	5	5	5	5	12.4
6	10	5	5	5	5	5	25	30	75	100	100	75	55	60	65	60	40	25	15	5	5	5	5	5	13.1
7	10	5	5	5	5	5	25	35	80	100	85	55	70	65	65	50	40	20	5	5	5	5	5	10	13.5
8	25	5	5	5	5	5	35	45	95	100	80	95	90	75	60	50	35	5	5	5	5	5	20	20	11.7
9	40	5	5	5	5	5	35	40	75	80	100	95	85	60	55	35	5	5	5	5	5	25	25	40	12.1
10	40	5	5	5	5	5	35	35	60	95	100	90	65	50	40	5	5	5	5	5	25	30	50	55	12.5
11	40	5	5	5	5	5	30	25	75	100	95	70	55	35	5	5	5	5	5	25	30	65	70	60	12.3
12	40	5	5	5	5	5	20	35	80	100	80	65	40	5	5	5	5	5	20	35	60	100	80	65	11.3

Note 1 — The 24—hour profile of both—way traffic between any two countries is read from left to right from the appropriate row of the table; all time differences can be expressed in the range 0—12 hours. Each entry is expressed as a percentage of the busy hour traffic.

Note 2 — The *more westerly* country of a traffic relation is the one from which we can proceed eastwards to the other through time zones not exceeding 12 hours.

Note 3 — For network planning studies, UTC (Universal Coordinated Time) would normally be used so that all traffic streams are processed time consistently. Clearly if the more westerly country is *W* hours ahead of UTC (ignoring the international dateline), then the traffic at 0000—0100 UTC is obtained from the row corresponding to the time difference between the two countries at the column headed *W*. Alternatively, the first entry in the appropriate row gives the relative traffic intensity for the hour (24—*W*) to (25—*W*).

Example: For the traffic stream between the U.K. (UTC + 1 hour) and the central zone of USA (UTC + 18 hours), the time difference is 7 hours and the USA is regarded as the more westerly country, hence *W* = 18. Thus from the table, the traffic during 0000—0100 UTC is 5 % of the busy hour traffic, and the busy hour is 1500—1600 UTC.

Note 4 — The column headed “BH %” gives the busy hour traffic volume as a percentage of the daily traffic volume.

MONTAGE Time difference (in hours) between two countries

TABLE 2/E.523

Diurnal distributions of eastbound international telephone traffic

Local time in the more westerly country

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0	10	5	5	5	5	5	10	10	50	90	100	95	85	70	85	85	70	45	25	40	40	35	20	15
1	5	5	5	5	5	5	10	30	80	95	100	90	80	80	85	80	60	35	30	40	35	25	15	10
2	5	5	5	5	5	5	25	40	85	100	100	90	90	85	85	60	40	45	35	40	25	20	15	5
3	5	5	5	5	5	5	40	50	90	100	95	100	95	80	65	40	55	45	35	25	20	10	5	5
4	5	5	5	5	5	5	35	50	70	85	100	100	85	60	40	50	50	40	25	20	15	5	5	5
5	5	5	5	5	5	5	30	40	70	95	100	90	65	45	50	50	50	25	20	15	5	5	5	5
6	10	5	5	5	5	5	40	45	85	100	100	65	45	55	55	50	30	20	15	5	5	5	5	5
7	10	5	5	5	5	5	40	50	90	100	75	40	60	55	55	40	30	10	5	5	5	5	5	10
8	25	5	5	5	5	5	55	65	100	100	70	90	85	70	45	35	25	5	5	5	5	5	20	20
9	50	5	5	5	5	5	40	45	70	75	100	100	85	55	50	35	5	5	5	5	5	25	35	60
10	65	5	5	5	5	5	45	45	60	95	100	90	60	45	35	5	5	5	5	5	25	30	75	100
11	65	5	5	5	5	5	40	40	75	90	80	55	40	25	5	5	5	5	5	20	25	80	100	95
12	55	5	5	5	5	5	20	40	65	70	50	40	20	5	5	5	5	5	20	25	70	100	90	80

Note — This table is based on $p = 1.4$, $q = 0.6$, i.e. greater weight is given to the convenience function of the called party (see Annex A).

MONTAGE Time difference (in hours) between two countries

TABLE 3/E.523

Diurnal distributions of westbound international telephone traffic

Local time in the more westerly country

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0	10	5	5	5	5	5	10	10	50	90	100	95	85	70	85	85	70	45	25	40	40	35	20	15
1	5	5	5	5	5	5	10	20	60	95	100	90	80	80	85	80	60	35	30	40	35	25	15	10
2	5	5	5	5	5	5	15	20	65	100	100	90	90	85	85	70	50	45	35	40	35	30	15	5
3	5	5	5	5	5	5	10	20	60	100	95	100	95	80	75	60	65	45	35	35	30	15	5	5
4	5	5	5	5	5	5	15	20	60	85	100	100	85	60	60	70	60	40	25	30	25	5	5	5
5	5	5	5	5	5	5	20	20	60	95	100	90	75	55	70	70	60	35	20	25	5	5	5	5
6	10	5	5	5	5	5	10	15	65	100	100	85	65	65	75	70	50	30	15	5	5	5	5	5
7	10	5	5	5	5	5	10	20	70	100	95	70	80	75	75	60	50	30	5	5	5	5	5	10
8	20	5	5	5	5	5	15	25	90	100	90	95	95	80	75	65	45	5	5	5	5	5	20	20
9	25	5	5	5	5	5	30	35	80	85	100	95	85	65	60	35	5	5	5	5	5	20	20	25
10	10	5	5	5	5	5	25	25	60	95	100	90	70	55	45	5	5	5	5	5	25	30	25	10
11	15	5	5	5	5	5	10	10	65	95	100	80	65	45	5	5	5	5	5	25	35	40	35	25
12	20	5	5	5	5	5	20	25	70	100	90	80	55	5	5	5	5	5	20	40	65	70	50	40

Note — This table is based on $p = 1.4$, $q = 0.6$, i.e. greater weight is given to the convenience function of the called party (see Annex A).

MONTAGE Time difference (in hours) between two countries

ANNEX A

(to Recommendation E.523)

MATHEMATICAL EXPRESSION FOR THE INFLUENCE OF TIME DIFFERENCES ON THE TRAFFIC FLOW

A telephone call is initiated when a person wishes to call someone else, but both parties have to be on the line before the call is established. It is considered that a telephone call is made at a time which tends to be convenient for both the calling and called parties. The degree of *convenience* for making a telephone call is considered to be a periodical function of time t, whose period is 24 hours. When the time difference between both parties is zero, the degree of convenience is denoted by $f(t)$, where t is local standard time. The graphic shape of the basic function $f(t)$ will be determined by the daily pattern of human activities, and will resemble, or fairly closely coincide with, the hour by hour traffic distribution in the national (or local) telephone network.

It is assumed that the hourly traffic distribution $F_\tau(t)$, when a time difference of τ hours exists between the originating and called locations, is expressed as the geometric mean of convenience functions of two locations τ hours apart:

$$F_{\tau,}(t) = \mathrm{k} \{ f(t) \cdot f(\tau)\}^{1/2}$$

where

$$\mathrm{k} = 1/ \int_{24\ \text{hours}} \{ f(t) \cdot f(t+\tau)\}^{1/2} dt \qquad \text{(A—1)}$$

The sign of τ is positive when the time at the destination is ahead of the reference time, and negative when the time of destination is behind the reference time.

The distribution of equation (A—1) represents the sum of the outgoing and incoming traffics. Expressions for the one—way hourly traffic distributions can also be obtained by extending the concept of convenience function as follows.

Define convenience functions both for the caller $f_0(t)$ and for the called party $f_i(t)$.Then the one—way traffic distributions of east—bound and west—bound telephone calls, for the case of τ hour time—difference, are similarly expressed as follows:

$$F_{\tau,\,\text{east}}(t) = \mathrm{k} \{ f_0(t) \cdot f_i(t+\tau)\}^{1/2}$$

$$\mathrm{k} = 1/ \int_{24\ \text{hours}} \{ f_0(t) \cdot f_i(t+\tau)\}^{1/2} dt \qquad \text{(A—2)}$$

$$F_{\tau,\,\text{west}}(t) = \mathrm{k} \{ f_i(t) \cdot f_0(t+\tau)\}^{1/2}$$

$$\mathrm{k} = 1/ \int_{24\ \text{hours}} \{ f_i(t) \cdot f_0(t+\tau)\}^{1/2} dt \qquad \text{(A—3)}$$

where

t is the local standard time of the west station and

τ is positive.

It is natural that a caller makes a call considering the convenience of the called person, and therefore the convenience function of the called person f_i contributes more than the convenience of the caller f_0 to the directional distribution F. They can be written as follows:

$$f_i(t) = k_1 \{ f(t) \}^p \quad f_0(t) = k_2 \{ f(t) \}^q \qquad \text{(A—4)}$$

where

$$p > q \text{ and } p + q = 2,$$

and where k_1 and k_2 are normalizing coefficients to ensure that:

$$\int_{24 \text{ hours}} f_i(t)\, dt = 1, \qquad \int_{24 \text{ hours}} f_0(t)\, dt = 1.$$

As to the values of p and q in equation (A—4), it has been found empirically that the convenience of the called side p is considerably larger than that of originating side q, and appropriate values are roughly $p = 1.4$ and consequently $q = 0.6$.

References

[1] CCITT Recommendation *International telephone routing plan*, Rec. E.171.

[2] CCITT Recommendation New system for accounting in international telephony, Rec. D.150.

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