INTERNATIONAL TELECOMMUNICATION UNION

CCITT

E.508

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

(10/92)

TELEPHONE NETWORK AND ISDN

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

FORECASTING NEW TELECOMMUNICATION SERVICES

Recommendation E.508

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation E.508 was revised by Study Group II and was approved under the Resolution No. 2 procedure on the 30th of October 1992.

CCITT NOTE

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

Recommendation E.508

FORECASTING NEW TELECOMMUNICATION SERVICES

(revised 1992)

1 Introduction

The operation and administration of a telecommunications network should include the consideration of subscriber demands for new services which may have different characteristics than the traditional traffic (i.e. peak busy hours, bandwidth requirements, and average call durations may be different). By addressing these new demands, Administrations can be more responsive to customer requirements for innovative telecommunications services. Based on the type of service and estimated demand for a service, network facilities and capacity may have to be augmented. An augmentation of the network could require large capital investments and additional functions and responsibilities.

Forecasting of new services can be done in the context of an overall approach illustrated in Figure 1/E.508.

Section 2 of this Recommendation classifies and discusses the definition of new services for the purpose of forecasting. The parameters (base data) related to the new services are outlined in Section 3. Section 4 introduces methods for use in forecasting new services. Section 5 describes methods for combining forecast results and Section 6 methods to evaluate forecast results.

Figure 1/E.508 includes an iteration loop with measurement of actual traffic. This type of loop is implicit in all forecasting processes, but it is particularly important where the uncertainties of original forecasts can be reduced by frequent updates.

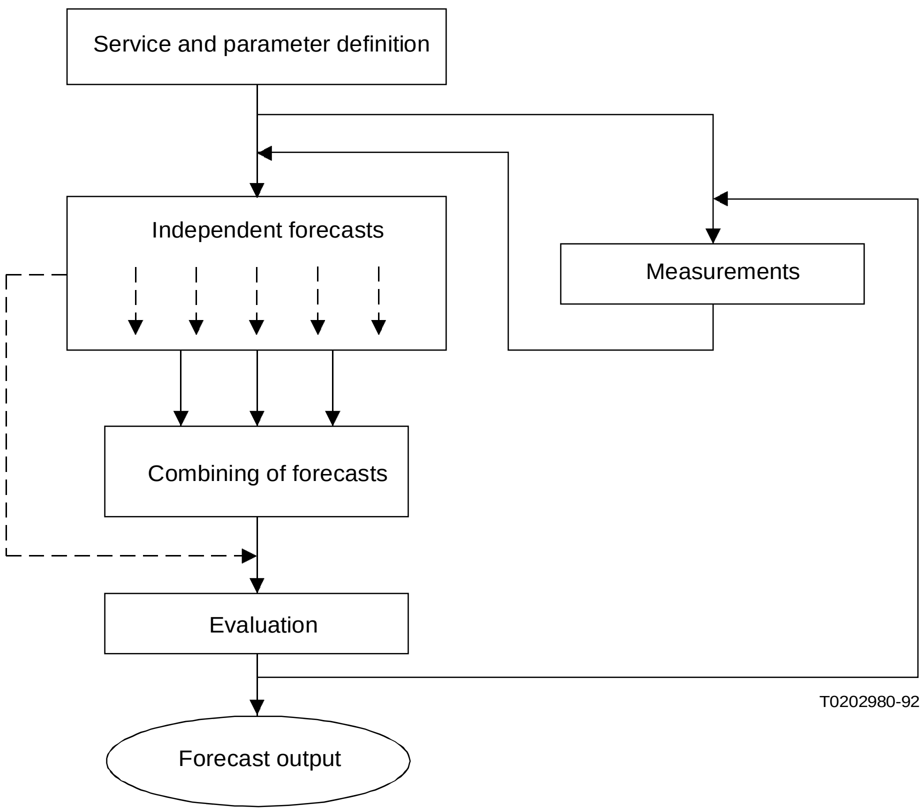

FIGURE 1/E.508

New services forecasting approach

2 New service classification

2.1 *General*

A distinction between those services which are enhancements of existing services carried on the existing telephone network and those services which are novel is useful.

Many of the services in this latter category will be carried on the Integrated Services Digital Network (ISDN). It is not the purpose of the section to provide an exhaustive list of services but rather to establish a framework for their classification. This framework is required because different base data and forecasting strategies may be necessary in each case.

2.2 **Enhanced services offered over the existing network**

These are services which are offered over the existing network, and which offer an enhancement of the original use for which the network was intended. Services such as the international freephone service, credit card calling and Closed User Groups are examples of enhancements of voice services, while facsimile Telefax and Videotex are examples of non-voice services. These services may be carried out over the existing network and, therefore, data will concern usage or offered load specific to the enhancement. Arrangements can be established for the measurement of this traffic, such as the use of special network access codes for non-voice applications or by sampling outgoing circuits for the proportion of non-voice to voice traffic. Examples of enhanced services are presented in Table 1/E.508.

TABLE 1/E.508

Examples of enhanced services

Enhancement of existing services
Teletex
Facsimile
Videotex
Message handling systems
International freephone
Automatic credit cards calling
Closed User Groups

2.3 **Novel services**

Novel services are defined as totally new service offerings many of which may be carried over the ISDN. In the case of ISDN, Recommendation I.210 divides telecommunications services into two broad categories: bearer services and teleservices. Recommendation I.210 further defines supplementary services which modify or supplement a basic telecommunications service. The definition of bearer services supported by the ISDN is contained in Recommendations I.210 and I.211, while that for teleservices is found in Recommendations I.210 and I.212. Bearer services may include circuit switched services from 64 kbit/s to 2 Mbit/s and packet services. Circuit switched services above 2 Mbit/s are for further study.

Teleservices may include Group 4 facsimile, mixed mode text and facsimile, 64 kbit/s teletex and videotex, videophone, videoconferencing, electronic funds transfer and point of sale transaction services. These lists are not exhaustive but indicate the nature and scope of bearer services and teleservices. Examples of novel services are presented in Table 2/E.508.

TABLE 2/E.508

Examples of novel services

"Novel" services	
Bearer services	Teleservices
Packet switched services	Group 4 facsimile Mixed mode Videophone
Circuit switched services – 64 kbit/s – 2 Mbit/s – Multipoints – 64 kbit/s	Videoconferencing Electronic funds transfer Point of sale transactions Teletex (64 kbit/s) Videotex (64 kbit/s)

For some novel services the demand will arise from new communication needs. These needs and their technical solutions are still rather uncertain and also influence the network architecture. Therefore it is essential to know the user applications, which represent the content of the service. This is partly a result of the technological development and partly a result of the new regulatory regime. The traditional chain of production: supplier industry-operator-user, develops into a far more complicated structure. The chain of production becomes in a certain sense longer, roughly like: supplier industry-bearer service – Value Added Network Services (VANS) – information services-user. The chain is complicated by a number of "spin-offs" supplying hardware, software and system services. Along with the more complicated structure, there is a shift in the dominating element in the chain: the information service supplier tends to be the dominating element structuring the whole chain. This is exactly what necessitates the knowledge of the user applications. As an illustrative example, some of the problems connected with forecasting of the demand for ISDN can be listed.

– The price elasticity for Plain Old Telephone Service (POTS) appears to be relatively low in the industrialized countries. This will probably not be the case for new services like ISDN. First of all because they will be more expensive than POTS (at least in the short run) but also because a number of alternatives exist (e.g. data networks, leased lines or means of communications based on systems other than telecommunications).

– Although the tariffs for ISDN will be of major importance in the users investment decision, the costs related to the introduction of ISDN include many other factors. New equipment has to be acquired and installed, personnel has to be trained and organizational changes may be necessary. The initial benefits, primarily savings on the payment for other telecommunication services, must outweigh the total of these costs or new applications must be very convincing.

– The fast technological development in the field of telecommunications reduces the lifetime of the users investments in ISDN. The fast decreasing prices on telecommunication equipment also reduce the economic lifetime of the hardware investments.

– The benefit of a certain service increases with the number of users connected to it [2]. This market externality makes the regulatory framework of particular importance. In a deregulated environment no guarantee is given that ISDN will ever be the dominating standard for data transmission services. Competing service solutions running on virtual private networks will constrain this development and reduce the demand.

– The demand for ISDN depends not only on the price of alternatives but also on their quality. Thus, the interest for ISDN has been much more pronounced in countries without well functioning data networks.

3 Forecasting parameters

3.1 *Measurement of enhanced services*

Measurements for existing services are available in terms of numbers of calls, call duration, erlangs, etc. These procedures are covered in Recommendation E.506, § 2. In order to measure/identify enhanced service data from other traffic data on the same network it may be necessary to establish sampling or other procedures to aid in the estimation of this traffic, as described in § 4 and § 5.

3.2 *Novel services*

Novel services, as defined in § 2, may be carried on the ISDN. In the case of the ISDN, circuit switched bearer services and their associated teleservices will be measured in 64 kbit/s increments. Packet switched bearer services and associated teleservices will be measured by a unit of throughput, for example, kilocharacters or kilopackets per second. Other characteristics will be needed when the uses of these services as discussed in § 2 may require additional statistical characterization beyond that used for telephony and enhanced services.

4 Independent forecasting methods

4.1 *General*

The absence of historical data is the fundamental difference between forecasting new services and forecasting existing services. The same forecast methodologies are dependent on the base data. For example, for a service already in existence in some countries, forecasting procedures for its introduction to a new country will involve historical data on other countries, its application to the new country and comparison of characteristics between countries. Other methods based on expert opinions or socio-economic analysis apply for both cases.

4.2 *Market research*

Market research is conducted to test consumer response and behaviour. This research employs the methods of questionnaires, market analysis, focus groups demonstration, trials and interviews. Its purpose is to determine consumers' intentions to purchase a service, attitudes towards new and existing services, price sensitivity and cross-services elasticities. Market research helps make decisions concerning which new services should be developed. A combination of the qualitative and quantitative phases of market research can be used in the initial stages of forecasting the demand for a new service.

The design of market research considers a sampling frame, customer/market stratification, the selection of a statistically random sample and the correction of results for non-response bias. The sample can be drawn from the entire market or from sub-segments of the market. In sampling different market segments, factors which characterize the segments must be alike with respect to consumer behaviour (small intragroup variance) and should differ as much as possible from other segments (large intergroup variance); each segment is homogeneous while different segments are heterogeneous.

The market research may be useful in forecasting existing services or the penetration of new services. The research may be used in forecasting novel services or any service which has no historical series of demand data. It is important that potential customers be given a complete description of the new service, including the terms and conditions which would accompany its provisioning. It is also important to ask the surveyees whether they would purchase the new service under a variety of illustrative tariff structures and levels. This aspect of market research will aid in redimensioning the demand upon final determination of the tariff structure and determining the customers' initial price sensitivity.

4.2.1 *Forecasting procedures*

4.2.2 *Sampling and questionnaire design*

The forecasting procedure for novel services based on market research is made up of five consecutive steps. The first of these consists in defining the scope of the study.

The second step involves the definition and selection of a sample from the population, where the population includes all potential customers which can be identified by qualitative market research developed through interviews at focus groups. The research can use stratified samples which involves grouping the population into homogeneous segments (or strata) and then sampling within each stratum. Stratification prevents the disproportionate representation of some parts of the population that can result by chance with simple random sampling. The sample can be structured to include specified numbers of respondents having characteristics that are known, or believed, to affect the subject of the research. Examples of customer characteristics would be socio-economic background and type of business.

The third step is the questionnaire design. A trade-off exists between obtaining as much information as practical and limiting the questionnaire to a reasonable length, as determined by the surveyor. Most questionnaires have three basic sections:

1) qualifying questions to determine if a knowledge person has been contacted;

2) basic questions including all questions which constitute the body of the questionnaire;

3) classification questions collecting background on demographic information.

The fourth step involves the implementation of the research – the actual surveying portion. Professional interviewers, or firms specializing in market research should be employed for interviewing.

The fifth and final step is the tabulation and analysis of the survey data.

4.2.3 *Conversion ratios for the sample*

Conversion ratios are used in estimating the proportion of respondents expressing an interest in the service who will eventually subscribe.

The analysis of the market research data based on a sample survey, where a stratified sample is drawn across market segments, for a service that is newly introduced or is planned, is discussed below:

Let

X_{1i} be the proportion of firms in market segment *i* that are very interested in the service.

X_{2i} be the proportion of firms in market segment *i* that are interested in the service.

X_{3i} be the proportion of firms in market segment *i* that are not interested in the service.

X_{4i} be the proportion of firms in market segment *i* that cannot decide whether they are interested or not.

The above example has four categories of responses. Greater or fewer categories may be used depending on the design of the questionnaire.

Notice that

$$\Sigma X_{ij} = 1 \qquad (4\text{-}1)$$

for each *i*, where *j* is the index of categories of responses.

Market research firms sometimes determine conversion ratios for selected product/service types. Conversion ratios depend on the nature of the service, the type of respondents, and the questionnaire and its implementation. Conversion ratios applying to the sample will estimate the expected proportion of firms in the survey that will eventually subscribe, over the planning period. For studies related to the estimation of conversion ratios, refer to [3], [4] and [5].

Then,

c_1X_{1i} is the proportion of firms in market segment *i* that expressed a strong interest and are expected to subscribe

c_2X_{2i} is the proportion of firms in market segment *i* that expressed an interest and are expected to subscribe.

c_3X_{3i} is the proportion of firms in market segment i that expressed no interest but are expected to subscribe.

c_4X_{4i} is the proportion of undecided firms in market segment i that are expected to subscribe.

where

c_j is the conversion ratio for response j.

The proportion of firms in market segment i, P_i, that are expected to subscribe to the service, equals

$$P_i = \sum_{j=1}^{4} c_j X_{ji} \tag{4-2}$$

The conversion ratio applies for the situations where a 100% market awareness has been reached. That is, all surveyees are fully informed of the service availability, use tariffs, technical parameters, etc. P_i therefore, can be interpreted as the long-run proportion of firms in market segment i that are expected to subscribe to the service at some future time period, T.

Two issues arise in the estimation of the proportion of customers that subscribe to the service:

1) while P_i refers to the sample surveyed, the results need to be extrapolated to represent the population;

2) P_i is the long-run (maximum) proportion of firms expected to subscribe. We are interested in predicting not just the eventual number of subscribers but, also, those at intermediate time periods before the service reaches a saturation point.

4.2.4 *Extrapolation from sample to population*

To extrapolate the data from the sample to represent the population, let

N_i be the size of market segment i (measured for example, by the number of firms in market segments i)

Then S_i, the expected number of subscribers in the planning horizon, equals

$$S_i = P_i N_i \tag{4-3}$$

4.2.5 *Market penetration over time*

To determine the expected number of subscribers at various points in time before the service reaches maturity, let

P_{it} be the proportion of firms in market segment i that are expected to subscribe at time t.

Clearly,

$P_{it} < P_i$

and

$P_{it} \rightarrow P_i$ as $t \rightarrow T$

The relation between P_{it} and P_i can be explicitly defined as:

$$P_{it} = a_{it} \cdot P_i \tag{4-4}$$

a_{it} is a penetration function, reflecting changing market awareness and acceptance of the service over time, in market segment i. An appropriate functional form for a_{it} should be bounded in the interval [0, 1]. Using demonstrations and trials one can influence the evaluation of a_{it}.

As an example let a_{it} be a logistic function:

$$a_{it} = \frac{1}{1 + e^{b_{it}}} \tag{4-5}$$

where $b_i \leq 0$ is the speed with which P_{it} tends to P_i in market segment i, as illustrated in Figure 2/E.508.

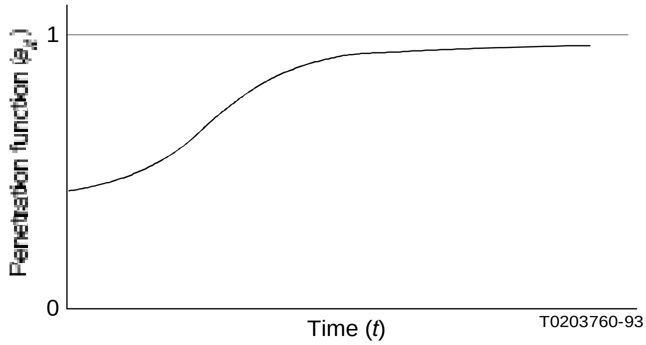

FIGURE 2/E.508

Rate of market penetration

For other examples of non-linear penetration functions, refer to the Annex A.

The introduction of a new service will usually differ according to the market segment. The rate of penetration may be expressed as a function of time, the speed of adjustment (b_i) may vary across segments. Lower absolute values of b_i, for the logistic function will imply faster rates of penetration.

While the form of the penetration function relating to the rate of penetration to time is the same for all segments, the parameter b_i varies across segments, being greater in segments with a later introduction of the new service.

Let

t_{0i} be the time period of introduction of service in market segment i.

Then

$t - t_{0i}$ is the time period elapsed since service was introduced in market segment i.

In the diagrammatic illustration, of Figure 3/E.508, the service has achieved the same level of market penetration a_0, in t_c periods after its introduction in market C as it did in t_A periods after its introduction in market segment A. Later introductions may not necessarily lead to faster rates of penetration across segments. However, within the same market segment, across countries with similar characteristics, such an expectation is reasonable.

4.2.6 *Growth of market segment over time*

The above discussion has accounted for gradual market penetration of the new service, by allowing P_{it} to adjust to P_i over time. The same argument can be extended to the size of market segment i over time.

Let n_{it} be the size of market segment i at time t.

Then, the expected number of subscribers at time t in market segment i, equals

$$S_{it} = a_{it} \cdot P_{it} \cdot n_{it} \tag{4-6}$$

and

$S_t = \sum_i S_{it}$ is the expected number of subscribers across all market segments at time t.

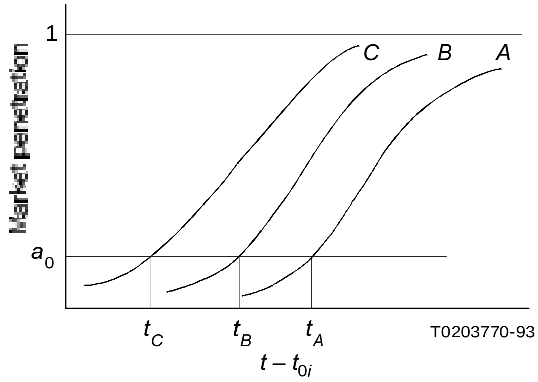

FIGURE 3/E.508

Market awareness of a function of time of introduction of service

4.2.7 *Quantities forecasted*

The above procedure forecasts the expected number of customers for a new service within a country. Other quantities of interest may include lines, minutes, messages, revenue, packets, kilobits, etc. The most straightforward forecasting method for some of these quantities is to assume constant relationships such as:

expected access lines = (average access lines) × expected number of subscribers;

expected minutes = (average use per line) × expected access lines;

expected messages = expected minutes/(average length of conversation);

expected revenue = (average rate per minute) × expected minutes.

The constants, appearing in parentheses, above, can be determined through

1) the process of market research; or

2) past trends in similar services.

4.2.8 *Forecasting with historical data: application analysis*

After a new service has been introduced, historical data can be analysed to forecast demand for expanded availability to other countries. Development of a new service will follow trends based on applications, such as data transmission, travel reservations, intracompany communications, and supplier contact. Applications of a service vary widely and no single variable may be an adequate indicator of total demand.

The following procedure links demand to country characteristics for forecasting expanded availability of a new service to other countries.

Let $D = (D_1, D_2......, D_n)$

represent a vector of country-specific annual demand for the service across n countries, where the service currently exists. Let C be the matrix of m characteristics relating to each of the n countries that are reasonable explanatory variables of demand. The components of m would vary depending on the nature of the service and its application.

Some essential components of m would be the price of the service (or an index representing its price) and some proxy for market awareness. As discussed in earlier sections, market awareness is one of the key determinants of the rate of market penetration of the service. Reasonable proxies would be advertising expenditures and time (measured as $t^* = t - t_0$) where t^* would measure time elapsed since the service was first introduced at time t_0. Market awareness can be characterized as some non-linear function of t^*, as presented in § 4.2.5. Other components of m may include socio-economic characteristics of the customers, market size and location of customers.

The model that is estimated is

$$D = C\beta + u \qquad (4\text{-}7)$$

where

C is a $(n \times m)$ matrix of country characteristics;

D is a $(n \times 1)$ vector of demand;

β is a $(m \times 1)$ vector of coefficients corresponding to each of the m characteristics;

$u = (n \times 1)$ vector of error terms.

The estimated regression is

$$\hat{D} = C\hat{\beta} \qquad (4\text{-}8)$$

Traditional methods of estimating regressions will be applied. Equation (4-8) can be used for predicting demand for any country where the service is being newly introduced, as long as elements of the matrix C are available.

4.3 *Expert methods*

For further study.

4.4 *Sectorial econometrics*

By means of analysis of existing telecommunications services by various socio-economic sectors or by technological development scenarios an attempt is made to determine if certain sectors will be the relevant users of a given service or if the service will be a type of universal service. An inference rule or a set of rules are established using econometric or other indicating a relation between variables in the economy and/or the sectors and the demand for new telecommunication services analysed as qualitative considerations as indicated. The total demand can be established after as many recursive analyses of this kind as is estimated relevant have been made.

An outline of this approach applied to broadband ISDN is given in Figure 4/E.508.

The inference values are developed from an examination of the factors that impact the utilization of services in each economic sector individually. Annex B gives an example of the influenced procedure applied to one economic sector in one country.

5 Combining forecasts

5.1 *General*

In today’s high-technology society numerous forecasting models, plus expert opinions are available to produce the best forecast. Each forecasting model is developed based on a particular set of assumptions and information set. Thus a certain forecasting method may be good at predicting random variables in some specific domains but not in others. In such a situation it may be extremely difficult for the decision maker to decide which forecasting model or expert will provide the best forecasts concerning stochastic process in question.

Thus, a principal motivation for combining forecasts has been to avoid the *a priori* choice of which forecasting methods to use. Also the combination of these forecasts yields a forecast that is indirectly based on the union of these information sets. Thus studies have shown that a combination of forecasts often outperforms the forecasts of a single model/expert [6], [7], and [8].

The combination forecasting approached can be classified into two major categories. One is the aggregation of different forecasts using weighting methods, and the other is an attempt to model the decision process of judgmental forecasting revision in a structured approach.

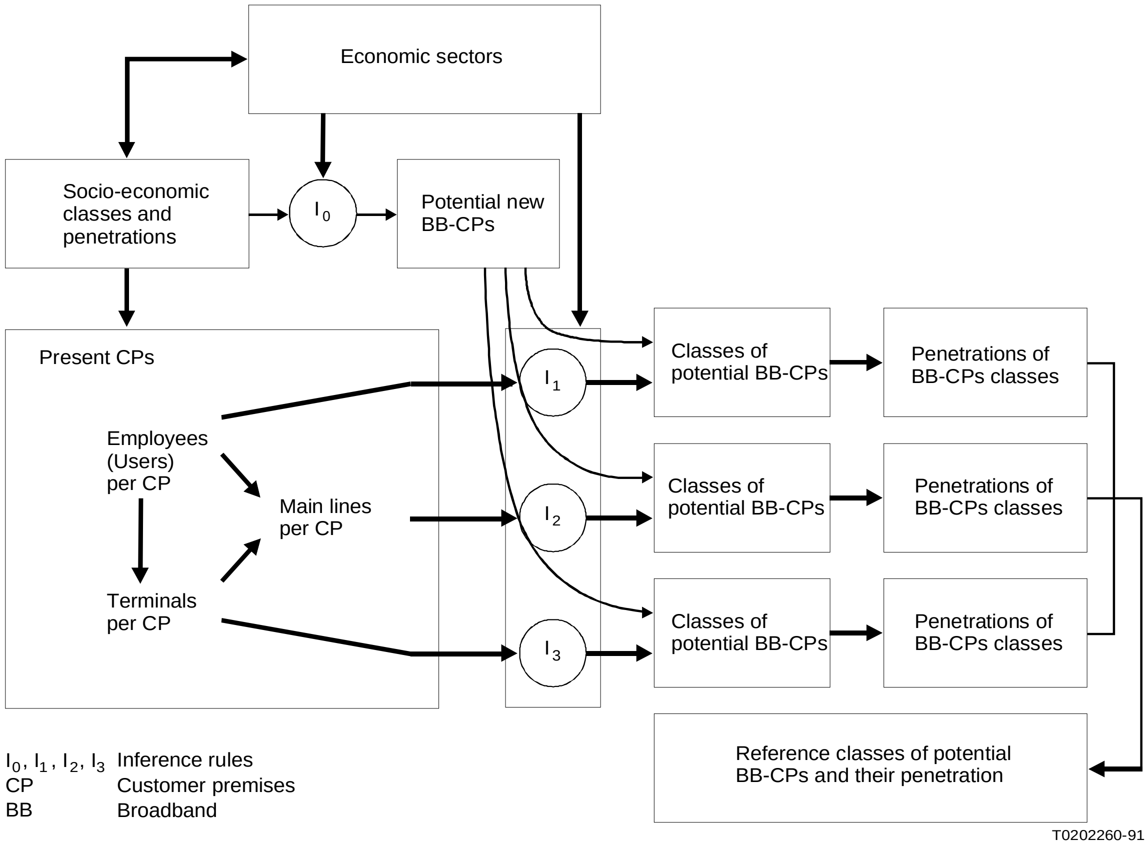

FIGURE 4/E.508

Example of sectorial-econometric forecasting

5.2 *Aggregation approach*

It is known that an aggregation of forecasts obtained from modes which may use different functions and/or information sets generally outperforms individual forecasts. Its conceptual background is as follows.

Due to the existence of competing theories on the underlying casual relationships, data availability and cost consideration, forecasts of the same variable of interest are often based on different information sets. As a less costly alternative to obtain a composite forecast by combining the models and the information sets themselves, a combination of these forecasts yields a forecast that is indirectly based on the union of these information sets.

On the other hand, since any given forecasting technique makes specific assumptions on the stochastic process generating the particular series, and may use a different error-minimizing criterion in parameter estimation, the models fit and the forecasts provided may capture certain characteristics of the series not captured by other forecasting techniques. For additional information see references [9] and [10].

By far the most popular way to capture and utilize the information in different forecasts is through linear aggregation. The ancillary decision problem of how best to employ the forecasts then reduces to the problem of how best to select the aggregation weights.

5.2.1 *Naive methods*

When the sample base is relatively small then the simpler methods of combination have been shown to be the more robust and effective approach:

a) simple average;

b) weighted average: The weight could be the fraction of time that a forecast has actually performed better or the ratio of MSE to the total MSE of all forecasts, etc.

5.2.2 *Regression based methods*

Even though the multicollinearity problems exist in working with the actual forecasts as independent variables in a regression model, combinations using regression weights is the presently preferred method:

a) unrestricted ordinary least square (OLS); if the forecasts are biased, an unrestricted OLS may be appropriate, since imposing constraints would reduce the efficiency of the out-of-sample combined forecasts;

b) restricted OLS.

If the forecasts being combined are all unbiased, or almost unbiased, then a gain in the efficiency of the out-of-sample combined forecasts may be achieved by using a restricted regression model.

5.2.3 *Adaptive method*

One of the major practical difficulties is that due to non-stationarity and structural change in the pattern of forecast errors. Many methods of combination have been suggested to cope with this including

a) *The state-space method:* Treats all forecasts that are being combined as endogenous variables, thus it may overcome the loss in the efficiency of the combined forecasts due to the multicollinearity problem.

b) *The weighted least square method:* This method weights the forecasts differentially based on the pattern of their error.

5.3 *Structured approach*

Relative lack of data, or even complete absence of data, requires any approach to new product forecasting problem to make many assumptions that are not too confidence inspiring. The best estimated are therefore obtained by a combination of multiple approached. This allows one to look at the problem from many angles, and examine the consequences of different sets of assumptions that have to be made. As a result of this examination, suitable adjustments to the assumptions can be made until a consistent set of assumptions is obtained, all of which one can feel comfortable with in the light of all available data.

For new telecommunications services forecasting the structural approach can be applied to scenario techniques which attempt to ascertain alternative future states and estimate their probabilities.

The addition of a structuring and consistency checking mechanism is required to enhance the analysing performance of scenario technique. This concept is called as Structured Scenario Technique and it tries to solve the following problems:

a) how to derive consistent and effective scenario?

b) how to analyse the impact of key factors and their trend?

For further information see references [11], [12] and [13].

5.4 *Procedure*

The structural scenario technique is the synthesizing of qualitative and quantitative informations to derive the consistent and probable future alternatives with the following typical procedure:

Step 1: Analyse the decisions and strategic concerns, and come up with confine definitions of objectives.

Step 2: Identify the key decision factors.

Step 3: Identify the key environmental factors which make n = an impact to the decision factors and identify areas of influence.

Step 4: Analyse the environmental factors and develop probabilities of the environmental factors.

Step 5: Define the scenario logics based on the consistency. There are two basic methodologies for implementing the consistency checking. One is the cross-impact analysis and the other is the Battelle method. These two methods are explained below.

Step 6: Select the final scenarios and study the implications.

5.4.1 *Cross-impact analysis*

Cross-impact analysis requires marginal and conditional probabilities for the pair of events as input. Using these probabilities the possible scenarios are ranked in the order of their likelihoods, scenario probabilities which are the joint probabilities of the consisting factors. The higher probability scenarios are chosen for the further study. There are many algorithms developed to derive scenario probabilities based on the available data.

5.4.2 *The Battelle method*

The Battelle method requires much simple input: the compatibility values for every possible pair of factors outcomes, which are the subjective weights. The Battelle method explicitly does not use probabilities and choose certain scenarios for further analysis based on average compatibility values or worst compatibility value criteria.

Example

To illustrate the Battelle method a simple example is introduced. Assume the new X_i Metropolitan Area Network (MAN) service demand is mainly determined by three factors (X_i):

1) the growth rate of installed LAN;
2) the technology progress in CPE market;
3) the relative tariff of MAN and each factor consist of two mutually exclusive but exhaustive events ($Xij = E_k$).

The marginal probability (p_i) and compatibility matrix (k_{ij}) are given by

Event	p_i	k_{ij}
$E_1 = X_{11}$	0.60	0 1 4 2 3 3
$E_2 = X_{12}$	0.40	1 0 3 5 4 2
$E_3 = X_{21}$	0.65	4 3 0 1 2 5
$E_4 = X_{22}$	0.35	2 5 1 0 4 3
$E_5 = X_{31}$	0.70	3 4 2 4 0 1
$E_6 = X_{32}$	0.30	3 2 5 3 1 0

where

0 No relation

1 Incompatible

2 Low compatibility

3 Medium compatibility

4 High compatibility

5 Very high compatibility

In this case there are eight possible scenarios:

Scenario	Compatibility set	Worst value compatibility
SC1 E1E3E5	(4, 3, 2)	2
SC2 E1E4E5	(2, 3, 4)	2
SC3 E1E3E6	(4, 3, 5)	3
SC4 E1E4E6	(2, 3, 3)	2
SC5 E2E3E5	(3, 4, 2)	2
SC6 E2E4E6	(5, 2, 3)	3
SC7 E2E3E6	(3, 2, 5)	2
SC8 E2E4E5	(5, 4, 4)	4

When we use the worst compatibility value criteria, the scenario 8 is chosen for further analysis.

Other methods for use in the structural scenario approach include intuitive logic and Trend-impact analysis.

5.4.3 *Intuitive logics*

Intuitive logic approach is not tied to any mathematical algorithm; it relies on an experienced scenario team.

5.4.4 *Trend-impact analysis*

Trend-impact analysis relies on an independent forecast of the key dependent variable, which is then adjusted based on occurrence of impacting events. This method successfully combines more traditional forecasting techniques such as time series and econometrics with qualitative forecast.

6 Forecast tests and adjustments

6.1 *General*

Forecast tests and adjustments are dependent on the methodology applied. For example, in the case of a market research based forecast, it is important to track the forecast of market size, awareness and rate of penetration over time and to adjust forecasts accordingly. However, for an application-based methodology, traditional tests and adjustments applicable to regression methods will be employed, as discussed below.

6.2 *Market research based analysis*

This subsection discusses adjustments to forecasts based on the methodology described in § 4.2. The methodology was based on quantification of responses from a sample survey.

The forecast was done in two parts:

a) extrapolating the sample to the population, using market size, N_i;

b) allowing for gradual market penetration (awareness), a_{it} of the new service over time.

The values attributed to n_{it} (which represents the size of market segment i at time t) and a_{it} can be tracked over time and forecast adjustments made in the following manner:

a) As an example for n_{it}, the segments could be categorized as travel or financial services. The size of the segment would be the number of tourists, and the number of large banks. Historical data, where available, on these units of measurement can be used to forecast their sizes at any point of time in the future. Where history is not available, reasonable growth factors can be developed through subject matter experts and past experiences. The forecast of n_{it} should be tracked against actual measured values and adjusted for large deviations.

b) For a_{it}, testing with only a few observations since the introduction of the service is more difficult.

Given that,

$$a_{it} = \frac{P_{it}}{P_i} \tag{6-1}$$

and P_i is assumed fixed (in the long run), testing a_{it} is equivalent to testing P_{it}. P_{it} can be tracked by observing the proportion of respondents that actually subscribe to the service at time t. This assumes the need to track the same individuals who were originally in the survey, as is customary in a panel survey. Panel data is collected through sample surveys of cross-sections of the same individuals, over time. This method is commonly used for household socio-economic surveys. Having observed P_{it} for a new period, values of a_{it} can be plotted against time to study the nature of the penetration function, a_{it}, and the most appropriate functional form that fits the data should be chosen. At very early stages of service introduction, traditional functional forms for market penetration, such as a logistic function, will be a reasonable form to assume. Other variations of the functional form depicting market penetration would be the Gompertz or Gauss growth curves. The restriction is that the penetration function should be bounded in the interval [0,1]. See Annex A for an algebraic depiction of functional forms.

There are various statistical forms that may be chosen as representations for the penetration function. The appropriate functional form should be based on some theoretical based information such as the expected nature of penetration of the specific service over time.

Continuous tracking of n_{it}, P_{it} and a_{it} over time will enable adjustments to these values whenever necessary and enable greater confidence in the forecasts.

6.3 *Application based analysis*

The application based analysis is a regression based approach and traditional forecast tests for a regression model will apply. For instance, hypothesis tests on each of the explanatory variables included in the model will be necessary. Corrections may be needed for hetero-elasticity, serial correlation and multicollinearity, when suspect. The methodology for performing such tests are described in most econometrics text books. In particular, references [2] and [4] can be used as guidelines. Recommendation E.507 also discusses these corrections.

Adjustments need to be made for variables that should be included in the regression model but are not easily quantifiable. For example, market awareness that results from advertising and promotional campaigns plays an important role in the growth of a new service, but data on such expenditures or the associated awareness may not be readily available. Some international services are targeted towards international travellers, and fluctuations in exchange rates will be a determining factor. Such variables, while not impossible to measure, may be expensive to acquire. However, expectations of future trends in such variables can enable the forecaster to arrive at some reasonable estimates of their impact on demand. Unexpected occurrences such as political turmoil and natural disasters in particular countries will also necessitate post forecast adjustments based upon managerial judgement.

Another important adjustment that may be necessary is the expected competition from other carriers offering similar or substitutable services. Competitor prices, if available, may be used as explanatory variables within the model and allow the measurement of a cross-price impact. In most situations, it is difficult to obtain competitor prices. In such cases, other methods of calculating competitor market shares need to be developed.

Regardless of forecasting methodology, the final forecasts will have to be reviewed by management responsible for planning the service as well as by network engineers in order to assess the feasibility both from a planning implementation and from a technical point of view.

6.4 *General evaluation methods*

6.4.1 *Bayesian revision*

Often it is necessary to form a forecast judgmentally before any data are available and then to revise the forecast in stages as observations are made. A major advantage of Bayesian methods is its ability to combine judgmental and empirical data in a statistically correct way to improve forecasting. Bayesian revision provides a method of developing a revised forecast by combining empirical data with forecast made prior to the empirical observations. The revised forecast is a function of the likelihood function of each forecast, which is the decision maker's subjective performance measurement of the forecasting method, and prior forecast of the decision maker. With the addition of observation the likelihood functions are revised. For more information see reference [16].

6.4.2 *Macroeconomic consistency check*

It is useful to include a macroeconomic consistency check, that is a check on whether the estimated demand is compatible with the general economic development.

– High investments in networks are constrained by the economic strength of the network operators. If additional funds have to be raised, the probability for funds from the government or other sources must be considered.

– Investments in telecommunications will constitute an increasing share of the total private investments. However, major jumps in the level of telecommunications investments will demand a potential for substantial savings in the use of telecommunications e.g. in form of increase in productivity – also in the short run. This will be accentuated if a raise in the level for the overall investments is necessary.

– Strains on balances in the national economy: it is unlikely that any telecommunications policy will be compatible with costs implying heavy deficits on the balance of payment of the government budgets.

ANNEX A

(to Recommendation E.508)

Penetration functions (growth curves)

Some examples of non-linear penetration functions are illustrated below.

A.1 *Logistic curve*

$$a_{it} = \alpha \,/\, \{1 + e^{-bt}\} \qquad \text{(A-1)}$$

For $\alpha = 1$, the curve is bounded in the interval [0,1]. Changing b will alter the steepness of the curve. The higher the value of b, the faster the rate of penetration. This curve is S-shaped and is symmetrical about its point of inflection, the latter being where

$$\frac{d^2 a_{it}}{dt^2} = 0 \qquad \text{(A-2)}$$

A.2 *Gompertz curve*

$$a_{it} = \alpha \exp \{-b e^{-kt}\} \quad \text{(A-3)}$$

As $t \rightarrow \infty$ $a_{it} \rightarrow \alpha$, the limiting growth.

Holding $k = 1$ and $\alpha = 1$, higher values of b will imply slower rates of penetration. This curve is also S-shaped like the logistic curve, but is not symmetrical about its inflection point.

When $t = 0$, then $a_{it} = \alpha e^{-b}$, which is the initial rate of penetration.

A.3 *Gauss curve*

$$a_{it} = \alpha (1 - e^{-bt^2}) \quad \text{(A-4)}$$

As $t \rightarrow \infty$, then $a_{it} \rightarrow \alpha$

As $t \rightarrow 0$, then $a_{it} \rightarrow 0$.

Choosing $\alpha = 1$, the curve is bounded in the interval [0,1].

ANNEX B

(to Recommendation E.508)

Example of forecasting using a sectoral rule

In this annex an example of demand forecasting for ISDN in the retail sector is presented. In this example, a sectoral inference rule is used. The data is based on the Copenhagen Telephone Company (KTAS) concession area in Denmark.

B.1 *Demand profile for the retail sector*

There are 48 898 shop sites altogether in Denmark. About 21 000 of these are within the KTAS concession area.

It is difficult to obtain data on the consumption of telecommunications services at the sectoral level. In this study the private sector share of the total demand for telecommunications was estimated at 28%. Assuming that the retail sector has the same average demand per employee as private services in general, the demand from the retail sector will constitute approximately 7.5% of the total demand and 11.5% of the business demand.

The telecommunications services currently dominating the retail sector are, apart from voice telephony, an Electronic Funds Transfer at the Point of Sale (EFTPOS) system included in the general Danish electronic payment system called Dankort and Telefax. In addition Electronic Data Interchange (EDI) is widely used in the retail sector.

At the national level the number of terminals for EFTPOS (excluding cash dispensers) is 16 000 in 1990 (12 000 in 1989 and 8000 in 1988). Practically all terminals are situated in retail shops. As some shops have more than one terminal about 20% of the shops are connected. In our region this implies approximately 4200 shops connected.

The total number of fax machines is 100 000. The majority is bought within the last three years. It is predicted that the number will have doubled in 1993[1)]. It is estimated that 7.5% of these will be used in the retail sector. This implies that 15% of shops (approximately 3100) are equipped with a fax.

[1)] The estimations are based on the observed and estimated sales figures from 1985-94 (Politiken 28.11.90 and FinTech 146/6).

While leased lines and packet-switch networks are widely used in e.g. the financial sector, the current EDI systems applied within the retail sector are mostly based on dial-up connections via the ordinary telephony network.

A simple form for EDI is used in most shops to place orders at the suppliers. 84% of the orders are managed in this way. Other types of communications than simple ordering of goods are channelled through other media.

We have no figures on the number of shops using more than one of these services. However, it is assumed that the use of the services is concentrated in the same shops. On this basis it is assumed that 30% of the shops are using at least one teleservice in addition to telephony.

B.2 *Content of telecommunications services*

The communication from the retail sector is directed forwards to its customers and backwards to its suppliers. The channels of communication to these two groups are quite different.

Today, electronic payment is the only telecommunication service in practical use directed towards the customers. This is actually communication between the retail sector and the financial sector. The infrastructure to be used for electronic communication directly between customers and the shops (e.g. homeshopping or advertising by fax or videotex) is not yet available.

The communication towards the suppliers is communication between businesses and the infrastructure is almost developed as connections between fax machines.

The benefits of using telecommunications services are both cost reduction and improved service. In electronic payment, the savings from the substitution of cheques is occurring mainly in the banks. However, the retail sector also gets some cost benefits: more efficient customer service at the cash terminals, easier cash counting, quicker transfer from banks and improved security. Nevertheless, the wide consumer acceptance of the Danish electronic payment card (Dankort) is the main force in a pressure towards installing terminals even in small shops. Introducing electronic payment is thus, from the retail sectors point of view, to a great extent an improved service to the customers.

The improvement of the communication channels to the suppliers by using fax or EDI is primarily a question of cost reduction. The cost reduction is related to transmission costs as well as improved efficiency in storage management, reducing storage costs, but also providing more flexibility in meeting the customers changing demand.

B.3 *Demand for ISDN: Three phases of diffusion*

The use of ISDN will develop in three subsequent phases:

1) transmission of existing telecommunication services by ISDN;

2) increasing use of existing services due to better functionality and price performance;

3) introduction of new ISDN-based services.

In the real world it will be difficult to distinguish the phases from each other, and there will be a tendency of overlapping. However, the phases are a useful tool in the description of how the demand will develop.

In the first phase an ISDN connection may replace two ordinary lines. In this phase the demand will depend heavily on the initial costs and tariffs: a tariff below the price of two ordinary telephone lines will introduce a cost incentive even for small customers[2]. The influence of initial costs is not considered in this example.

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[2] International predictions for the ISDN tariff indicate a tariff between 1.2 and 1.7 times the price of voice telephony.

A reduction in costs related to telefax and electronic payment, will further increase the high growth rates in these services. This will especially hold for the use of telefax, as the demand for electronic payment systems will come close to the saturation level within a few years.

The introduction of group 4 fax, will improve quality and reduce costs considerably for ISDN customers. Hence, the use of fax will increase.

The development of EDI and related services, will probably be more or less independent of the development of ISDN. The transmission does not seem to be an important obstacle for the diffusion. Lack of standards and low penetration of terminals play more important roles.

Initiatives within the sector have been launched to solve these problems, and EDI will in a few years, replace other means of communication between the shops and its suppliers. EDI will thus, to a wide extent, replace the use of fax machines in the retail sector. Hence, the demand for telefax will follow more modest growth rates than predicted for the economy as a whole.

In the short run, the migration from telefax to EDI will tend to reduce the traffic demand, as EDI is a much more efficient medium for transfer of structured data. However, in the long run this efficiency may boost the amount of data transferred, and outweigh this reduction.

B.4 *Forecasting the demand*

In the retail sector the main benefit of ISDN in the first phase, will be to integrate data traffic mainly originating from EFTPOS terminals and ordinary voice telephony into one connection. If the tariff for ISDN will be less than the double of an ordinary telephone line, this will represent an immediate cost-reduction. As this application does not require any changes in other parts of the production process, a rather quick diffusion can be foreseen.

The same could be said about integration of telefax or EDI with voice telephony. However, in this case the sharing of lines is also possible today, but implies certain inconveniences.

The application of ISDN will increase the speed of the EFTPOS terminals, and thus improve the service. Another advantage could be that the same number can be used for both fax and telephony. For these reasons there will be demand even if the tariff is the double of an ordinary connection or more. However, in this case the diffusion will be slow.

We assume now, that a tariff below twice the price of a telephone connection will result in a 100% connection of all shops with an EFTPOS terminal and a 50% connection of shops with EDI or telefax (but no EFTPOS terminal). A tariff above this level will result in a 50% connection of shops with EFTPOS terminals and 10% for shops using fax or EDI. Shops with telephony only will not demand ISDN. This will result in the demand indicated in Table B-1/E.508 if ISDN is introduced immediately.

TABLE B-1/E.508

Demand for ISDN in the retail sector – First phase

	Number of shops	% of all shops
Low tariff	5250	25
High tariff	2300	11

In the second phase the penetration of ISDN among users of the various applications will be at the same level, however the number of users will have increased, due to better functionality of the applications.

In phase three applications demanding ISDN will have been developed. Examples are ISDN fax, advanced EFTPOS with additional facilities, and EDI. These applications will result in a demand less sensitive to the tariff.

In Figure B-1/E.508 the demand is depicted.

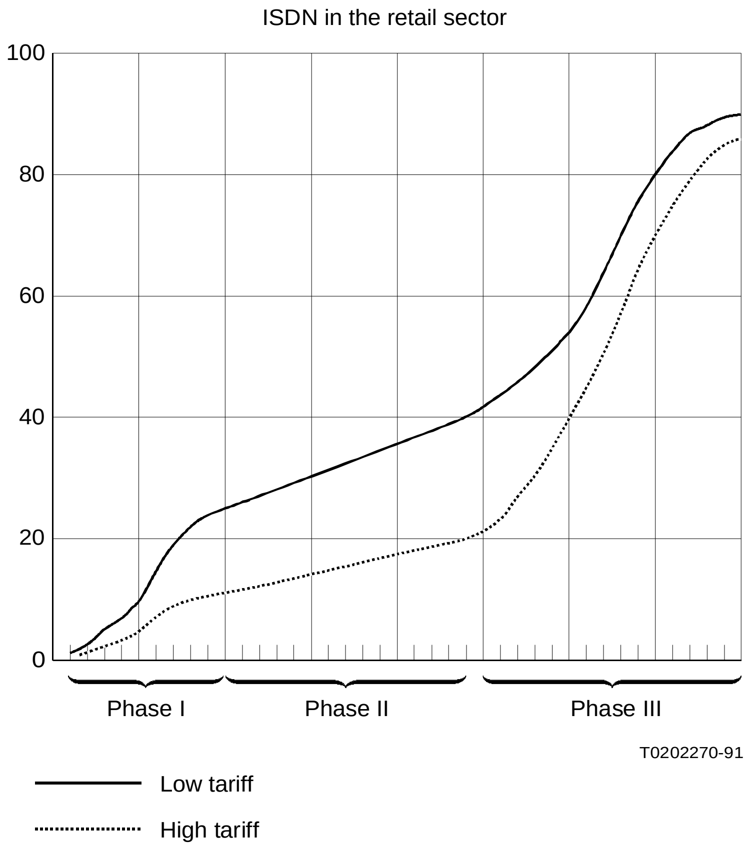

FIGURE B-1/E.508

Three phases of demand

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