INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

E.750

(03/2000)

SERIES E: OVERALL NETWORK OPERATION, TELEPHONE SERVICE, SERVICE OPERATION AND HUMAN FACTORS

Quality of service, network management and traffic engineering – Traffic engineering – Mobile network traffic engineering

---

Introduction to the E.750 series of Recommendations on traffic engineering aspects of networks supporting personal communications services

ITU-T Recommendation E.750

(Formerly CCITT Recommendation)

ITU-T E-SERIES RECOMMENDATIONS

OVERALL NETWORK OPERATION, TELEPHONE SERVICE, SERVICE OPERATION AND HUMAN FACTORS

OPERATION, NUMBERING, ROUTING AND MOBILE SERVICES	
INTERNATIONAL OPERATION	
Definitions	E.100–E.103
General provisions concerning Administrations	E.104–E.119
General provisions concerning users	E.120–E.139
Operation of international telephone services	E.140–E.159
Numbering plan of the international telephone service	E.160–E.169
International routing plan	E.170–E.179
Tones in national signalling systems	E.180–E.199
Maritime mobile service and public land mobile service	E.200–E.229
OPERATIONAL PROVISIONS RELATING TO CHARGING AND ACCOUNTING IN THE INTERNATIONAL TELEPHONE SERVICE	
Charging in the international telephone service	E.230–E.249
Measuring and recording call durations for accounting purposes	E.260–E.269
UTILIZATION OF THE INTERNATIONAL TELEPHONE NETWORK FOR NON-TELEPHONY APPLICATIONS	
General	E.300–E.319
Phototelegraphy	E.320–E.329
ISDN PROVISIONS CONCERNING USERS	E.330–E.399
QUALITY OF SERVICE, NETWORK MANAGEMENT AND TRAFFIC ENGINEERING	
NETWORK MANAGEMENT	
International service statistics	E.400–E.409
International network management	E.410–E.419
Checking the quality of the international telephone service	E.420–E.489
TRAFFIC ENGINEERING	
Measurement and recording of traffic	E.490–E.505
Forecasting of traffic	E.506–E.509
Determination of the number of circuits in manual operation	E.510–E.519
Determination of the number of circuits in automatic and semi-automatic operation	E.520–E.539
Grade of service	E.540–E.599
Definitions	E.600–E.699
ISDN traffic engineering	E.700–E.749
Mobile network traffic engineering	**E.750–E.799**
QUALITY OF TELECOMMUNICATION SERVICES: CONCEPTS, MODELS, OBJECTIVES AND DEPENDABILITY PLANNING	
Terms and definitions related to the quality of telecommunication services	E.800–E.809
Models for telecommunication services	E.810–E.844
Objectives for quality of service and related concepts of telecommunication services	E.845–E.859
Use of quality of service objectives for planning of telecommunication networks	E.860–E.879
Field data collection and evaluation on the performance of equipment, networks and services	E.880–E.899

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATION E.750

INTRODUCTION TO THE E.750 SERIES OF RECOMMENDATIONS ON TRAFFIC ENGINEERING ASPECTS OF NETWORKS SUPPORTING PERSONAL COMMUNICATIONS SERVICES

Summary

The E.750 series is intended to cover traffic engineering aspects related to terminal and personal mobility.

This Recommendation outlines the scope and the structure of the E.750 series. Recommendations in the E.750 series are identified by a three-digit number. Recommendations with the third digit in the range 0 to 4 are either of a general nature or apply to mobile networks; Recommendations with the third digit in the range 5 to 9 normally apply to UPT.

Source

ITU-T Recommendation E.750 was revised by ITU-T Study Group 2 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on 13 March 2000.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The ITU-T 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 World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

INTELLECTUAL PROPERTY RIGHTS

The ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. The ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Recommendation E.750

INTRODUCTION TO THE E.750 SERIES OF RECOMMENDATIONS ON TRAFFIC ENGINEERING ASPECTS OF NETWORKS SUPPORTING PERSONAL COMMUNICATIONS SERVICES

(revised in 2000)

1 Scope

The E.750 series is intended to cover traffic engineering aspects related to terminal and personal mobility.

Terminal mobility involves the ability of the user to be in continuous motion whilst accessing and using telecommunication services and the capability of the network to keep track of the location of the user's terminal. This requires the telecommunication services to be available throughout a spatial volume and ideally at all times.

Personal mobility is conferred by flexibility of the users access to telecommunication service provision which is available at any terminal, in such a way that the user identifies with, and may configure any of these terminals, fixed or mobile, to meet the user's requirements. These requirements may then be relocated from terminal to terminal. Personal mobility involves the network capability to locate the user on the basis of a unique personal identity (e.g. UPT number) for the purposes of addressing, routing and charging of the user's calls.

This Recommendation outlines the scope and the structure of the E.750 series. Recommendations in the E.750 series are identified by a three-digit number. Recommendations with the third digit in the range 0 to 4 are either of a general nature or apply to mobile networks; Recommendations with the third digit in the range 5 to 9 normally apply to UPT.

1.1 Terminal mobility

The E.750 series of Recommendations focuses initially on circuit switched traffic and common channel signalling traffic. Packet switched connections are for further study. The series considers the impact of mobile related traffic demands on both radio resources and fixed network resources, i.e. PSTN, ISDN and SS No. 7 networks. This recognizes the use of radio technology as either a separate or integral part of PSTN/ISDN.

The Recommendations in the E.750 series are applicable to both existing and emerging public land mobile systems. Examples of second generation digital systems include: GSM (Europe), NADC (North America) and PDC (Japan). IMT-2000 and UMTS represent examples of advanced (third generation) systems which are being specified in the ITU and ETSI, respectively. Teletraffic issues related to interworking with B-ISDN (including MANs) are for further study.

The E.750 series of Recommendations is also applicable to maritime and aeronautical systems, both terrestrial- and satellite-based. An example of satellite-based systems are the INMARSAT systems A, Aero, M and B.

1.2 Personal mobility

The E.750 series is intended to be phased with the progress of the definition of the UPT service. In particular, the series will initially concentrate on UPT service set 1.

2 Related Recommendations

The following Recommendations are the ones applicable at the time of publication of this Recommendation.

Recommendations related to terminal mobility include:

- ITU-T Recommendation E.220 (1996), *Interconnection of public land mobile networks (PLMN)*.
- CCITT Recommendation E.723 (1992), *Grade-of-service parameters for Signalling System No. 7 networks*.
- CCITT Recommendation F.111 (1991), *Principles of service for mobile systems*.
- ITU-T Recommendation F.115 (1995), *Service objectives and principles for future public land mobile telecommunication systems*.
- ITU-R Recommendation M.687-2 (1997), *International Mobile Telecommunications-2000 (IMT-2000)*.
- ITU-R Recommendation M.816-1 (1997), *Framework for services supported on International Mobile Telecommunications-2000 (IMT-2000)*.
- ITU-R Recommendation M.1079 (1993), *Speech and voiceband data performance requirements for International Mobile Telecommunications-2000 (IMT-2000)*.
- ITU-R Recommendation M.1168 (1995), *Framework for International Mobile Telecommunications-2000 (IMT-2000)*.
- ITU-R Recommendation M.1308 (1997), *Evolution of land mobile systems towards IMT-2000*.
- CCITT Recommendation Q.1001 (1988), *General aspects of public land mobile networks*.
- CCITT Recommendation Q.1002 (1988), *Network functions*.
- CCITT Recommendation Q.1003 (1988), *Location registration procedures*.

A comprehensive list of Recommendations related to the overall subject of mobile systems and services is given in Recommendation E.201 (Reference Recommendation for mobile services).

Recommendations related to UPT aspects include:

- ITU-T Recommendation E.168 (1999), *Application of E.164 numbering plan for UPT*.
- ITU-T Recommendation E.174 (1995), *Routing principles and guidance for Universal Personal Telecommunications (UPT)*.
- CCITT Recommendation E.723 (1992), *Grade-of-service parameters for Signalling System No. 7 networks*.
- ITU-T Recommendation F.851 (1995), *Universal Personal Telecommunication (UPT) – Service description (service set 1)*.
- CCITT Recommendation I.312/Q.1201 (1992), *Principles of intelligent network architecture*.
- ITU-T Recommendation I.373 (1993), *Network capabilities to support Universal Personal Telecommunication (UPT)*.

Finally, the following Recommendations address traffic modelling:

– CCITT Recommendation E.711 (1992), *User demand modelling*.

– CCITT Recommendation E.712 (1992), *User plane traffic modelling*.

– CCITT Recommendation E.713 (1992), *Control plane traffic modelling*.

– CCITT Recommendation E.720 (1988), *ISDN grade of service concept*.

– ITU-T Recommendation E.721 (1999), *Network grade of service parameters and target values for circuit-switched services in the evolving ISDN*.

3 Abbreviations

This Recommendation uses the following abbreviations:

B-ISDN	Broadband Integrated Services Digital Network
ETSI	European Telecommunications Standards Institute
GSM	Global System for Mobile communications
IMT-2000	International Mobile Telecommunications-2000
IN	Intelligent Network
ISDN	Integrated Services Digital Network
MAN	Metropolitan Area Network
NADC	North American Digital Cellular
PLMN	Public Land Mobile Network
PDC	Personal Digital Cellular
PSTN	Public Switched Telephone Network
SS No. 7	Signalling System No. 7
UMTS	Universal Mobile Telecommunication System
UPT	Universal Personal Telecommunication

4 Introduction

Mobile services are expanding at a very high rate all over the world and mobile related traffic is forecast to represent a significant share of the overall traffic increase in the years to come. A parallel increase is also being expected in the radio coverage, with incurred consequences on the fixed network infrastructure. This situation is leading to an impact of mobile related traffic on the fixed network which has to be measured, forecast and appropriately handled, to ensure that it does not create service impairment.

Consideration of mobile traffic characteristics and control, and identification of teletraffic interfaces between mobile and fixed network domain are important problems to be addressed in view of the variety of and the pace at which different architecture and scope for mobile systems are being proposed worldwide. Other key objectives of the E.750 series relating to terminal mobility are to provide methods for:

i) dimensioning radio transmission resources; and

ii) partitioning available spectrum among different cell types (e.g. micro- and macrocells) in overlaid cellular layouts as a result of capacity and coverage considerations.

UPT is expected to be introduced initially by making use of the existing technology, hence its potential is estimated high from its inception.

It is recognized that in the long-term UPT will provide a wide range of services using IN capabilities and may also have a significant wireless access component. In the near-term, however, it is anticipated that the primary focus will be on service-specific architecture solutions (ISDN/PSTN/PLMN) with voice as a priority. UPT performance Recommendations should therefore follow a phased approach taking account of such influencing factors as the increasing wireless access component, the signalling network and IN architecture, and the registration/authentication arrangements for access security.

5 Organization and content of the E.750 series

Recommendations in the E.750 series are grouped into five major categories. These are:

- General: Recommendations E.750 to E.759.
- Traffic modelling: Recommendations E.760 to E.769.
- Grade of service: Recommendations E.770 to E.779.
- Dimensioning methods: Recommendations E.780 to E.789.
- Traffic measurements: Recommendations E.790 to E.799.

Figure 1 shows the organization and the development of the E.750 series. One of the objectives of the E.750 series is the characterization of the mobile related traffic, both in the user and in the control plane, at the interface where mobile and fixed networks interconnect.

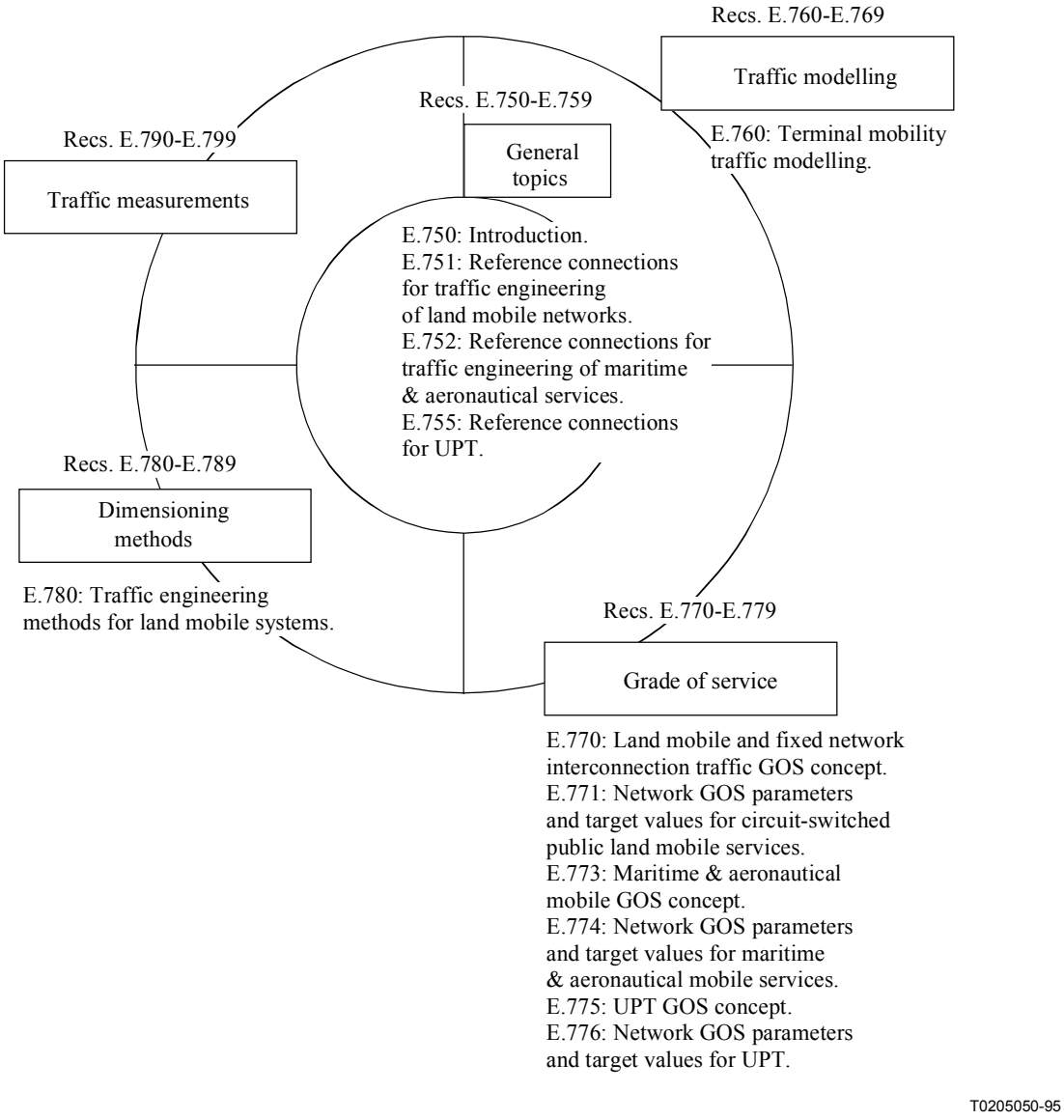

Figure 1/E.750 – Organization and existing/proposed Recommendations in the E.750-series Recommendations

Due to the characteristics of the mobile services and the radio environments, several issues (like location tracking, channel quality monitoring, handover handling, etc.) not relevant for fixed networks have to be considered for characterizing the mobile related traffic. Such issues normally add to those necessary to describe fixed network related traffic.

Basic functions required to support UPT include location registration, UPT user authentication, database interworking for number translation and supplementary services handling, and service profile management. The message interchanges required for these functions introduce new teletraffic engineering problems which must be addressed to ensure smooth and efficient introduction of UPT.

The E.750 series will model traffic processes using the user plane and control plane notions in a similar fashion as done in the E.700 to E.749 series of Recommendations on traffic engineering of the ISDN.

Recommendations in the E.750 series are summarized in Table 1.

Table 1/E.750 – Recommendations in the E.750 series

Rec.	Title	Status (at the time of publication of this Recommendation)
E.750	Introduction to the E.750 series of Recommendations on traffic engineering aspects of networks supporting personal communications services	First approved in 1993, revised in 1996 and 2000
E.751	Reference connections for traffic engineering of land mobile networks	First approved in 1993, revised in 1996
E.752	Reference connections for traffic engineering of maritime and aeronautical systems	First approved in 1996
E.755	Reference connections for UPT traffic performance and GOS	First approved in 1996
E.760	Terminal mobility traffic modelling	First approved in 2000
E.770	Land mobile and fixed network interconnection traffic grade of service concept	First approved in 1993
E.771	Network grade of service parameters and target values for circuit-switched land mobile services	First approved in 1993, revised in 1996
E.773	Maritime and aeronautical mobile grade of service concept	First approved in 1996
E.774	Network grade of service parameters and target values for maritime and aeronautical mobile services	First approved in 1996
E.775	UPT grade of service concept	First approved in 1996
E.776	Network grade of service parameters for UPT	First approved in 1996
E.780	Traffic dimensioning methods for land mobile systems	Draft

6 History

Recommendation first published in 1993, revised in 1996 and 2000.

Bibliography

COX (D.C.): Wireless personal communications: What is it?, *IEEE Personal Communications Magazine*, Vol. 2, No. 3, pp. 18-22, April 1995.

FRANKS (R.L.), WIRTH (P.E.): UPT traffic issues – An agenda for the 90s, 8th ITC specialist seminar on universal personal telecommunication, Santa Margherita Ligure, 12-14 October 1992.

GOODMAN (D.J.): Second generation wireless information networks, *IEEE Trans. Veh. Technol.*, Vol. VT-40, No. 2, pp. 291-302, May 1991.

GRILLO (D.), LEWIS (A.), PANDYA (R.), VILLEN-ALTAMIRANO (M.): CCITT E.700 Recommendations series – A framework for traffic engineering of ISDN, *IEEE Journal on selected areas in communications*, Vol. 9, No. 2, pp. 135-141, February 1991.

GRILLO (D.): Personal Communications and Traffic Engineering in ITU-T – The Developing E.750 series of Recommendations, *IEEE Personal Communications*, Vol. 3, No. 6, December 1996, pp. 16-28.

GRILLO (D.), SKOOG (R.A.), CHIA (S.), LEUNG (K.K.): Teletraffic Engineering for Mobile Personal Communications in ITU-T Work – The Need for Matching Practice and Theory, *IEEE Personal Communications*, Vol. 5, No. 6, December 1998, pp. 38-58.

IEEE Personal Communications, Special Issue on The European Path towards Advanced Mobile Systems, (D. Grillo, S.T.S. Chia and N. Rouelle Eds.), Vol. 2, No. 1, February 1995.

IEEE Personal Communications, Special Issue on IMT-2000: Standards Efforts of the ITU, (M.H. Callendar Ed.), Vol. 4, No. 4, August 1997.

IEEE Journal on Selected Areas in Communications, Special Issue on Personal Communications – Services, Architecture, and Performance Issues, (D. Grillo, et al. Eds.), Vol. 15, No. 8, October 1997.

IEEE Personal Communications, Special Issue on Paving the Way to Third-Generation Mobile Systems in Europe (D. Grillo, Ed.), Vol. 5, No. 2, April 1998.

IEEE Personal Communications, Special Issue on Advanced Mobile Systems: Managing Complexity in a Competitive and Seamless Environment, (D. Grillo, and J. Schwarz Dasilva Eds.), Vol. 6, No. 2, April 1999.

LAM (D.), COX (D.C.), WIDOM (J.): Teletraffic Modelling for Personal Communications Services, *IEEE Commun. Mag.*, February 1997, pp. 79-87.

MOULY (M.), PAUTET (M.B.): The GSM system for mobile communication, *Europe Media Duplication S.A.*, Lessay-les-Châteaux, 1993.

PANDYA (R.): Emerging Mobile and Personal Communication Systems, *IEEE Communications Magazine*, pp. 44-52, June 1995.

RAPELI (J.): UMTS – Targets, system concept and standardization in a global framework, *IEEE Personal Communications Magazine, special issue on The European Path towards Advanced Mobile Systems*, Vol. 2, No. 1, February 1995, pp. 20-28.

WIRTH (P.E.): The Role of Teletraffic Modelling in the New Communications Paradigms, *IEEE Communications Magazine*, Vol. 35, No. 8, August 1997, pp. 86-92.

APPENDIX I

A perspective for progressing traffic engineering for networks supporting terminal mobility

I.1 Current practices for the operation of cellular systems

As engineering procedures for mobile systems have only relatively recently started to be standardized, the operation of cellular systems is frequently based on simple rules for traffic demand estimation and resource allocation, complemented with monitoring and tuning the system performance in the field as the network evolves. To illustrate this process, it is instructive to assume a "green field" situation, although in many instances similar issues could be faced by operators who are still evolving their infrastructure. Key aspects are summarized in Figure I.1. In the figure, a simplified view of the complex relationship between the radio planning and the capacity dimensioning process is also shown.

The dimensioning process starts with an estimation of the user population by using the density of the inhabitants in a specific area together with an anticipated service penetration rate. Radio and network planners continue with the identification of sites where the cellular infrastructure has to be laid down (typically, base transceiver stations, base station controllers and mobile switches), and the mapping of user density into traffic demand. The process then finishes with the allocation of the traffic (radio) channels making judicious use of the available spectrum[1].

[1] It should be noted that the ultimate traffic capacity of a base site is highly dependent on the exact locations of the base sites. While every effort is usually made during the planning stage to ensure that a base site can be well positioned, the actual site acquisition process is subject to many factors including the physical location, real estate cost, the height of the location, the availability of equipment and antenna space, etc.

The accomplishment of the dimensioning cycle requires that numerous optimization problems be solved. These range from minimizing the number of the base sites while guaranteeing sufficient coverage and acceptable service quality, to planning the reuse of spectrum so as to accommodate the traffic demand while ensuring stable system operation and user satisfaction – to name just a few.

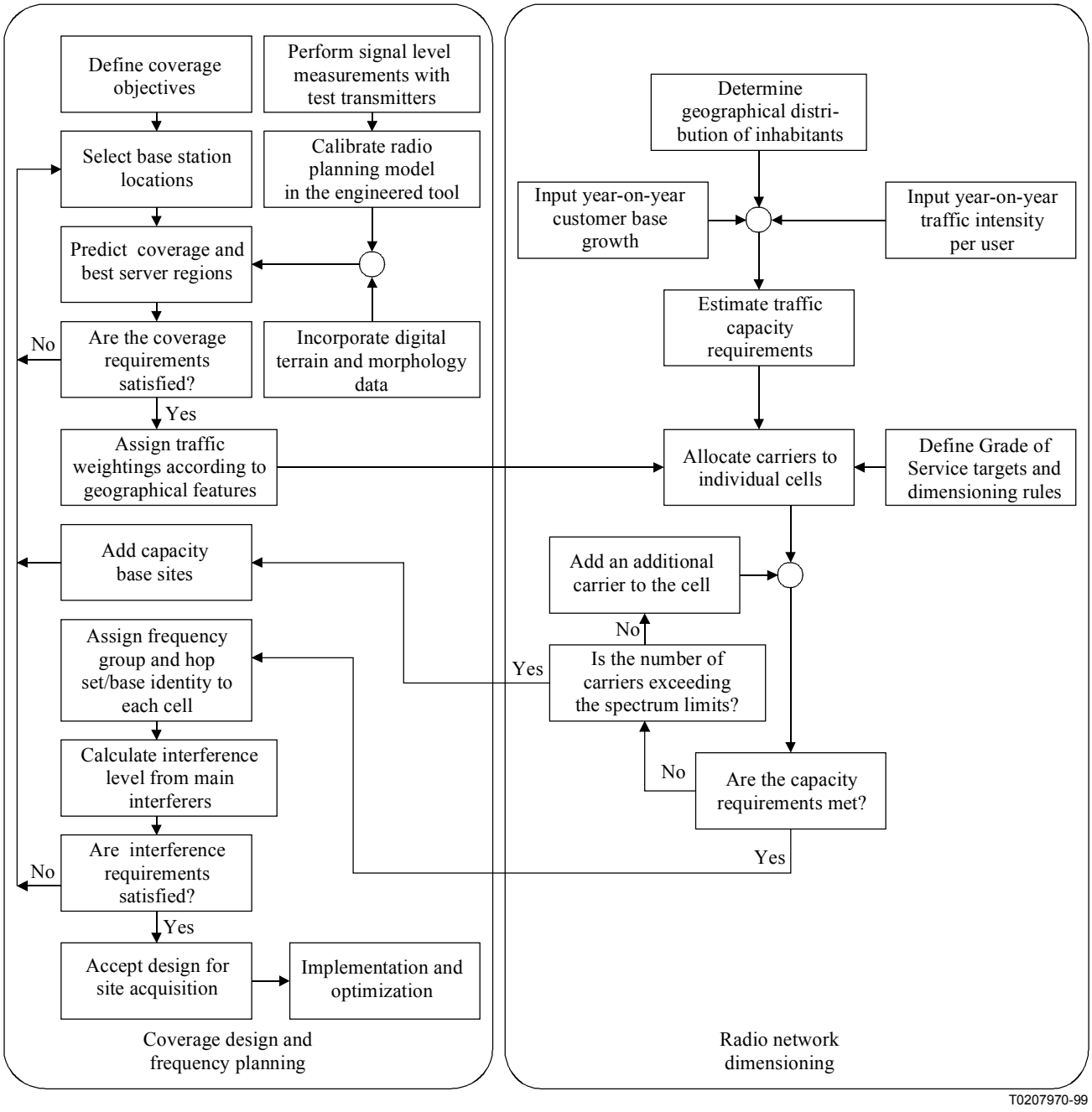

Figure I-1/E.750 – A summary of the radio planning and capacity dimensioning processes

The success in operating a system is assessed, among others, by the degree of control exercised over such phenomena as dropped calls, repeated call attempts and handover cases. All these phenomena will penalize user expectations about satisfactory service quality and, more often than not, many of these shortcomings are due to poor balancing of operation parameters.

I.2 Traffic engineering approach

Given the many dimensions of the traffic engineering tasks, on one hand, and the evolving technological scenario for mobile systems and services, on the other hand, it is clear that a development path has to be identified for producing Recommendations in the E.750 series. Restricting the attention to terminal mobility aspects, this path should enable the coverage of all important aspects of traffic engineering in the complex relationship between radio coverage and frequency planning, and radio network dimensioning – while allowing for a progressive extension of the subjects covered so as to build on consolidated material.

In particular, it seems that a sensible approach should be based on the following principles:

- Traffic engineering for mobile networks is part of a complex cycle whose aim is to optimize the dimensioning of the radio network. Traffic engineering should help in rationalizing key phases in the cycle and contribute to the identification of operation regions which are both stable and cost-effective from a resource usage point of view. The actual operating region shall be identified in the field through fine-tuning of the operation parameters, with radio transmission and coverage constraints playing a decisive role.
- An effective way for traffic engineering to feed in the cycle would be to make available a series of "modules" for addressing mobility, traffic demand and dimensioning aspects with teletraffic significance. These modules should be scaleable and accommodate both the geographical scope of the network and the fundamental differences in the architecture of mobile systems and the radio transmission techniques used in the radio interface(s).
- The scope of traffic engineering for networks supporting terminal mobility depends on a multitude of factors affecting, among others, network architecture, network planning principles and network operation. The combination of the possible options related to these factors identifies scenarios characterized by different system deployment and operation complexity – and consequently different degree of complexity from a traffic engineering point of view. A possible strategy for developing Recommendations in the E.750 series relating to terminal mobility modelling and dimensioning methods for mobile systems could be to consider scenarios of increasing complexity, with less complex system being addressed first. This phased approach would enable to address a large base of actual systems and capitalize on stable results.

ITU-T RECOMMENDATIONS SERIES

Series A	Organization of the work of the ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	**Overall network operation, telephone service, service operation and human factors**
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	Global information infrastructure and Internet protocol aspects
Series Z	Languages and general software aspects for telecommunication systems

18546

Printed in Switzerland
Geneva, 2001