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

International routing plan

QoS routing and related traffic engineering methods – Traffic engineering operational requirements

ITU-T Recommendation E.360.7

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ITU-T Recommendation E.360.7

QoS routing and related traffic engineering methods – Traffic engineering operational requirements

Summary

The E.360.x series of Recommendations describes, analyzes, and recommends methods which control a network's response to traffic demands and other stimuli, such as link failures or node failures. The functions discussed and recommendations made related to traffic engineering (TE) are consistent with the definition given in the Framework document of the Traffic Engineering Working Group (TEWG) within the Internet Engineering Task Force (IETF):

Internet Traffic Engineering is concerned with the performance optimization of operational networks. It encompasses the measurement, modeling, characterization, and control of Internet traffic, and the application of techniques to achieve specific performance objectives, including the reliable and expeditious movement of traffic through the network, the efficient utilization of network resources, and the planning of network capacity.

The methods addressed in the E.360.x series include call and connection routing, QoS resource management, routing table management, dynamic transport routing, capacity management, and operational requirements. Some of the methods proposed herein are also addressed in or are closely related to those proposed in ITU-T Recs E.170 to E.179 and E.350 to E.353 for routing, E.410 to E.419 for network management and E.490 to E.780 for other traffic engineering issues.

The recommended methods are meant to apply to IP-based, ATM-based, and TDM-based networks, as well as the interworking between these network technologies. Essentially, all of the methods recommended are already widely applied in operational networks worldwide, particularly in PSTN networks employing TDM-based technology. However, these methods are shown to be extensible to packet-based technologies, that is, to IP-based and ATM-based technologies, and it is important that networks which evolve to employ these packet technologies have a sound foundation of methods to apply. Hence, it is the intent that the methods recommended in this series of Recommendations be used as a basis for requirements for specific methods, and, as needed, for protocol development in IP-based, ATM-based, and TDM-based networks to implement the methods.

The methods encompassed in this Recommendation include traffic management through control of routing functions, which include QoS resource management. Results of analysis models are presented which illustrate the tradeoffs between various approaches. Based on the results of these studies, as well as established practice and experience, methods are recommended for consideration in network evolution to IP-based, ATM-based, and/or TDM-based technologies.

Source

ITU-T Recommendation E.360.7 was prepared by ITU-T Study Group 2 (2001-2004) and approved under the WTSA Resolution 1 procedure on 16 May 2002.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. 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 Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 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.

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As of the date of approval of this Recommendation, 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.

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Introduction

As discussed in the E.360.x series of Recommendations, Figure 1/E.360.1 illustrates a model for network routing and network management and design. The central box represents the network, which can have various configurations, and the traffic routing tables and transport routing tables within the network. Routing tables describe the route choices from an originating node to a terminating node for a connection request for a particular service. Hierarchical, nonhierarchical, fixed, and dynamic routing tables have all been discussed in these series of Recommendations. Routing tables are used for a multiplicity of services on the telecommunications network, such as an MPLS/TE-based network used for illustration in this Recommendation.

Traffic engineering functions include traffic management, capacity management, and network planning. Figure 1/E.360.1 illustrates these functions as interacting feedback loops around the network. The input driving the network is a noisy traffic load, consisting of predictable average demand components added to unknown forecast error and other load variation components. The feedback controls function to regulate the service provided by the network through traffic management controls, capacity adjustments, and routing adjustments. Traffic management provides monitoring of network performance through collection and display of real-time traffic and performance data and allows traffic management controls such as code blocks, connection request gapping, and reroute controls to be inserted when circumstances warrant. Capacity management includes capacity forecasting, daily and weekly performance monitoring, and short-term network adjustment. Forecasting operates over a multiyear forecast interval and drives network capacity expansion. Daily and weekly performance monitoring identify any service problems in the network. If service problems are detected, short-term network adjustment can include routing table updates and, if necessary, short-term capacity additions to alleviate service problems. Updated routing tables are sent to the switching systems either directly or via an automated routing update system. Short-term capacity additions are the exception, and most capacity changes are normally forecasted, planned, scheduled and managed over a period of months, or a year or more. Network design embedded in capacity management includes routing design and capacity design. Network planning includes longer-term node planning and transport network planning, which operates over a horizon of months to years to plan and implement new node and transport capacity.

In 6.2 to 6.5, we focus on the steps involved in traffic management of the MPLS/TE-based network (see 6.2), capacity forecasting in the MPLS/TE-based network (see 6.3), daily and weekly performance monitoring (see 6.4), and short-term network adjustment in the MPLS/TE-based network (see 6.5). For each of these three topics, we illustrate the steps involved with examples.

Monitoring of traffic and performance data is a critical issue for traffic management, capacity forecasting, daily and weekly performance monitoring, and short-term network adjustment. This topic is receiving attention in IP-based networks [FGLRR99] where traffic and performance data has been somewhat lacking, in contrast to TDM-based networks where such TE monitoring data has been developed to a sophisticated standard over a period of time [A98]. The discussions in this Recommendation intend to point out the kind and frequency of TE traffic and performance data required to support each function.

See ITU-T Recs E.490 to E.504 on general principles and requirements for traffic measurements and GOS monitoring; E.505 and E.743 on measurements for SS7 signalling networks; E.745 on measurements for ATM networks and E.506 to E.508 on forecasting methods.