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VoIP SERVICE QUALITY



*Measuring
and Evaluating
Packet-Switched
Voice*

WILLIAM C. HARDY

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Packet-Switched Voice

William C. Hardy



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PREFACE

The focus of this book is the narrow question of how to assess quality of packet-switched voice services in general and VoIP services in particular. The approach taken in answering this vexing question is one that I have exploited to very good effect in more than 35 years' working in the general area of test and evaluation of telecommunications systems. In applying this technique I

- Imagine myself using the system that is the subject of evaluation
- Decide what I would be concerned about if I were to be its user
- Research the technology of the system to the extent necessary to understand the mechanisms determining system performance that affected what I would experience with respect to those concerns
- Formalize the relationships between system performance and user perception of quality gleaned in this manner

The result is invariably a system of measurement and evaluation whose rationale is almost self-evident to even the most casual student of the system and often smacks of trivial observation to persons immersed in its intricate, microscopic technical details. The present treatment of packet-switched voice services is probably no exception. What is presented here will to some be painfully long on development of general measurement concepts and measurement technology and short on the specific details of implementation of the measures and models defined. As a consequence, the reader should not expect, for example, to find in this volume a complete set of equations for calculating PESQ (Perceptual Evaluation of Speech Quality) measures. What the reader should walk away with, however, is a very good understanding of the basis for PESQ, how it was developed, its strengths and weaknesses for various applications, when to use it, when to avoid its use, and, most important, why. The objective is to arm the reader with the perspectives and understanding that will enable a similar assessment of the next new be-all, end-all technique for predicting likely user assessment of quality of the next new packet-switched voice service, and the ones after that, and the ones after those.

—WILLIAM C. HARDY

INTRODUCTION

In today's environment nearly all end-to-end telephone connections are set up via *circuit switching*, whereby node-to-node links in an origin/destination connection are set up via interconnects, and the connection is maintained exclusively for exchanges of information between the origin and destination until it is torn down. An alternate way of setting up end-to-end connections that is widely used for transmission of data is *packet switching*, such as that used in the Internet, whereby origin-to-destination connections are effected by node-to-node, store-and-forward relay of small segments of data sets that are reassembled at the destination.

Since digital data sets transmitted across a packet-switched network might as easily comprise digitized voice signals as anything else, there is no issue as to whether voice can be transmitted via packet-switched network. However, the essential question remains as to whether, and/or under what circumstances, packet-switched transport will adequately support telephony and other applications, such as multimedia conferencing, requiring near-real-time, multidirectional exchanges of voice signals.

The possibility of creating such interactive packet-switched voice services creates both opportunities and a problem for development. The development of viable packet-switched voice transport creates opportunities both for merging the transport of voice and data services, thereby realizing substantial operational flexibility and economies in switching voice service, and for development of new services, such as integrated messaging, that would exploit the characteristics of a packet-switched network. The problem is that it is not clear whether, or under what circumstances, the quality of packet-switched voice services will be satisfactory for their intended uses.

To resolve this quandary and safely exploit packet-switching technology where possible, communications service managers must be able to assess the operational characteristics of packet-switched voice services relative to the needs of their application and determine how users are likely to perceive the quality of those services. At the same time, telecommunications service providers must be able to configure and operate packet-switched networks in a way that assures requirements for user perception of quality of service (QoS) are met.

The material in this book is intended to facilitate the development of capabilities for accomplishing these ends by setting forth a framework for measurement and evaluation of *perceived quality of service* of packet-switched voice services relative to different applications. It is based on

the more general foundations for measurement and evaluation of telecommunications QoS presented in Ref. 1, often appealing to concepts introduced in that book and adding the specifics needed for their application to packet-switched voice services.

The presentation is divided into three parts:

- Part 1, Foundations, contains all of the background material needed for understanding the factors that affect users' perception of, and satisfaction with, quality of packet-switched voice services. It covers the basic notions of quality of service derived from analysis of user concerns with quality, together with descriptions of the system-level interactions that determine what users will experience when voice exchanges are packet-switched.
- Part 2, Measurement and Evaluation of Voice Quality, turns to the central question of ways and means of gauging likely user perception of the quality of packet-switched voice services with respect to the audible quality of voice and naturalness of the exchanges. It describes commonly used techniques for measuring and analyzing voice quality, together with procedures for using such measures to determine what levels of performance of the packet-switched transport are needed to ensure that the voice quality will be acceptable to users.
- Part 3, Other Aspects of Quality of Service, concludes this book with brief descriptions of the ways and means of measuring and gauging likely user perception of packet-switched voice services with respect to the other user concerns with telecommunications QoS described in Ref. 1 and some of the unique quality requirements associated with some kinds of packet-switched voice services.