

Chapter XI

Perceptual Voice Quality Measurements for Wireless Networks

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ABSTRACT

Perceptual voice quality measurement can be defined as an objective quantification of an overall impression of the perceived stimulus. An alternative to laborious subjective testing is objective predictive modelling, which employs a perceptual model of the human auditory and cognitive system to predict the human response to a voice signal in terms of its quality. This chapter describes subjective and automated objective testing methods, and provides a test case scenario for measuring voice quality.

INTRODUCTION

Wireless communications have opened up a range of new opportunities for telecommunication companies and service providers. In particular, wireless local area networks (WLANs), continue to provide increasing data bandwidth at lower cost, and now enable support for advanced mobile services. Although most existing wireless LANs based on the IEEE 802.11 specifications (the popular Wi-Fi networks) are predominantly

targeted at best effort data traffic, there has been a very strong interest in integrating support for voice traffic using VoIP. Given the performance limitations of these wireless systems, assessing and addressing the perceptual voice quality is of major importance for both service providers and telecommunication system designers.

Perceptual voice quality measurement can be defined as an objective quantification of an overall impression of the perceived stimulus. Until the 1990s, the most reliable method for obtaining

true perceptual measurement was to conduct a subjective test, which gives the group's mean opinion score (MOS) of the quality of a voice signal under evaluation. Subjective tests are, however, slow and expensive to conduct, making them accessible only to a small number of laboratories and unsuitable for long-term or large scale voice quality monitoring.

An alternative to the subjective tests is represented by objective predictive modelling techniques. This approach employs the use of a perceptual model of the human auditory and cognitive system to predict the human response to a voice signal in terms of its quality. Such approaches are reported to be highly effective as the aim of the perceptual models is to simulate the response of listeners (end-users) participating in a subjective test. This has made the objective predictive modelling techniques very attractive for meeting the demands for perceptual voice quality measurements. Objective measurement techniques can be sub-divided into two types of predictive models:

- a. **Intrusive models:** Compare an original voice signal with its degraded version that has been processed by a network under test. Due to their use of both signals (original and distorted) for processing such models are also known as comparison-based or full-reference.
- b. **Non-intrusive models** can be used in mainly two configurations: (1) *Non-intrusive signal-based models* (also termed as no-reference, or single-ended models) where only the distorted voice signal is required for measuring its perceptual quality and (2) *non-intrusive parametric models*. Here, instead of using voice signals, several properties of the underlying transport and/or terminal, such as echo, delay, noise, network characteristics and reception measures are used to estimate the subjective MOS.

Following this introduction, Section 2 details the tests and methods used during subjective determination of voice quality. Due to their high price and time consuming subjective testing is not always practical. Automated objective models that can replace the subjective testing are reviewed in Section 3. Methods that are widely used for voice quality measurements for wireless networks are identified in Section 4. In addition, a test case scenario for measuring voice quality using the first wireless test platform for IEEE 802.11 wireless networks is also presented. Section 5 concludes the chapter and discusses future trends.

SUBJECTIVE DETERMINATION OF VOICE QUALITY

Voice quality assessment measures that are based on ratings by human listeners are called subjective measures (ITU-T Recommendation P.800, 1996). These tests seek to quantify the range of opinions that listeners express when they hear voice transmission of systems that are under test. Properly designed subjective tests provide the most accurate way of assessing voice quality. However, the results of subjective tests are influenced by the conditions of the tests such as (ITU-T Recommendation E. 800, 1994):

- **Speech material:** Perception of a speech signal depends on the gender of talkers, their particular pronunciation, the language, content, and length of the signal.
- **Test set-up:** Results for the same test can vary depending on the listener's previous experience with listening tests, nationality, the duration of the test, and the level of understanding.
- **Listening conditions:** The individual ratings during the test are influenced by the loudness of the presented speech signals and choice of equipment used (i.e. headphones/telephone handset).

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