INTERNATIONAL TELECOMMUNICATION UNION

**TELECOMMUNICATION STANDARDIZATION SECTOR**

STUDY PERIOD 2001-2004

**COM 12 – D 104 – E**

**English only**

**Question:** 8/12 Geneva, 27-31 January 2003

**STUDY GROUP 12 – DELAYED CONTRIBUTION 104**

**Source:** Telchemy Incorporated

**Title:** Modelling Burst Packet Loss within the E Model

# ABSTRACT

This contribution discusses the modeling of burst packet loss within the context of the E Model. Companion contributions discuss the nature of burst packet loss, jitter and related packet discards, and illustrate that it is important to consider *sparse* bursts rather than *contiguous* bursts of loss/discard. A specific burst model is proposed for use with the E Model. This proposal is similar in nature to that described by AT&T in D.22 [1].

## 1 Introduction

Companion contributions illustrate that bursts of packet loss and jitter-related packet discards are often in the form of long sparse bursts that can be seconds in length with loss rates of typically 30%. For the purpose of this contribution we will refer specifically to *sparse bursts* or *contiguous bursts*, and we will assume that the burst incorporates both lost and discarded packets.

Bursts of consecutive lost packets (i.e. contiguous bursts) do occur however the various academic studies of packet loss distribution available suggest that most contiguous bursts are of length one packet, a smaller proportion of length two or three packets however there is the occasional very long contiguous burst (sometimes hundreds of packets in length) due to link failure within the IP network.

Much of the focus in the E Model and in subjective testing of CODECs has been on the effects of contiguous bursts, although some studies (such as [2] and [3]) have used sparse bursts. Whilst the number of successive lost packets does have an impact on the effectiveness of packet loss concealment algorithms, as stated above it is usually the case that contiguous bursts only comprise one packet. It is suggested that commonly observed sparse bursts of loss/discard with loss rates of 20-30 percent would have substantially more impact and should be the primary focus.

**Contact:** Alan Clark
Telchemy Incorporated
USA
Tel: +1 770 614 6944 ext 100
Fax: +1 770 614 3951
Email: alan@telchemy.com

**Attention:** This is not a publication made available to the public, but **an internal ITU-T Document** intended only for use by the Member States of the ITU, by ITU-T Sector Members and Associates, and their respective staff and collaborators in their ITU related work. It shall not be made available to, and used by, any other persons or entities without the prior written consent of the ITU-T.

The implication of the results showing that loss and discards typically occur as *sparse bursts* is that Voice over IP calls would typically have low or zero packet loss for much of the call and high loss rates (say 30%) for short periods.

As an example, say a three minute G.729A call experienced two 3 seconds periods of 30% packet loss rate. This means that the call statistics would be:

Average packet loss rate = 1%

R Factor during 96.7% of the call = 82 or an estimated MOS of 4.1

R Factor during 3 second bursts = 37 or an estimated MOS of 1.9

This would obviously be very obvious to the user of the VoIP connection and may result in a complaint.

## 2 Proposed Packet Loss Model

A companion contribution describes a number of packet loss distribution models and in particular highlights the ability of the Gilbert-Elliott model to represent sparse bursts. It also introduces a 4 state Markov model that is able to both represent sparse bursts and to capture consecutive loss events within bursts.

It is proposed that at least a Gilbert-Elliott model be incorporated into the E Model's toolkit. This can be specified in terms of the average burst length and burst loss density, and the average gap length and gap loss density, where a gap is defined as an interval between two bursts.

More complete definitions of bursts and gaps are:

(i) Let received mean that a packet is received and not discarded due to jitter

(ii) Let lost mean that a packet was either not received or was discarded

(iii) A burst is a maximal interval bounded by lost packets such that the number of consecutive packets received within the burst is less than some value $G_{min}$.

(iv) A gap is a maximal interval bounded by received packets such that the number of consecutive packets received between lost packets is $G_{min}$ or greater

(v) $G_{min}$ is a parameter with a suggested default value of 16.

This definition ensures that a gap is a period of time during which the packet loss rate is low and only isolated packets may be lost and a burst is a period of time during which the packet loss rate is high enough to be problematic (at least 6.7% with the default value of $G_{min}$).

## 3 Use of packet loss model in Transmission Planning

The characteristics of an IP network can be either measured or can be estimated through network simulation. It is suggested that the packet loss model be applied as follows:

(i) For the operational conditions expected, CODEC types and delays

(ii) Determine the mean or range of burst lengths and densities for the type of connection being analyzed and determine the associated mean or range of degraded *burst R factors*

(iii) Determine the background loss rate and determine the associated *gap R factor*

(iv) Determine the probability of a call experiencing any error event

(v) Determine the conditional probability of a call experiencing subsequent events

This would allow the following to be estimated:

(a) Estimated transmission quality for a “good” call not experiencing loss conditions

(b) The expected proportion of calls that would experience loss conditions

(c) The expected severity of “degraded call quality events” in terms of R factor and event length

## 4 Summary

This contribution proposes that:

(i) The E Model recognize that packet loss/discard in IP networks typically occurs in *sparse bursts*

(ii) G.107, or one of its attendant Recommendations, be extended to incorporate a Gilbert-Elliott or 4 state Markov model to represent sparse burst packet loss conditions.

(iii) That some guidelines on the use of the burst packet loss model for transmission planning be established

## 5 References

[1] ITU-T SG12 D.22 A framework for setting packet loss objectives for VoIP, AT&T October 2001.

[2] ITU-T COM 12-28 The Effect of Packet Losses on Speech Quality, Telia, July 2001.

[3] ITU-T SG12 D.139 Study of the relationship between instantaneous and overall subjective speech quality for time varying quality speech sequences, France Telecom, May 2000.

[4] ITU-T G.107 The E Model: A computational model for use in planning.