Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Mean Traffic Bit Rate with ON-SID Modeling of VoIP Traffic**
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Re:	IEEE 802.16m-07/080r2– Call for Comments on Draft 802.16m Evaluation Methodology Document
Abstract	This document contains proposed text for the draft evaluation methodology for IEEE 802.16m technical proposals.
Purpose	For discussion and approval by TGm
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Mean Traffic Bit Rate with ON-SID Modeling of VoIP Traffic

References

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[2] P. Pragtong, T. Erke, and K. M. Ahmed,” Modeling of VoIP Conversational Speech in Noisy Environment,” TENCON 2005 2005 IEEE Region 10, Nov. 2005, pp. 1- 5

[3] 3GPP TSG-RAN1#48 R1-070674, LTE Physical layer frame work for performance verification, Orange, China Mobile, KPN, NTT DoCcMo, Sprint, T-Mobile, Vodafone, Telecom Italia, February 2007

[4] R. Estepa, A. Estepa and J. Vozmediano,” Accurate Prediction of VoIP Traffic Mean Bit Rate”, Electronics Letters, 18th August 2005, Vol. 41, No. 17

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1. Introduction

Voice over IP (VoIP) is the transmitting of the packetized voiced signal through the lnternet and these IP packets are reassembly at the receiver side. The generation of these IP packets has been modeled by the traditional telephony ON-OFF model to mark the alternating talk and silence sequence, with the sequence duration follows the exponential distribution function. This ON-OFF model can be represented by a simple 2-state voice activity Markov model with proper conditional probabilities of transitioning from state 1 (ON, the active speech state) to state 0 (OFF, the inactive or silence state) and from the state 0 to state 1. In the active state, IP packets of fixed sizes are generated at a fixed interval while no packets are generated during the voice inactive state.

2. ON-SID Model

In the above ON-OFF model it does not have any packets sent in the silence period, however in the modern audio codecs in order to improve the conversation quality by a-periodically or periodically generating, during silence period, a shorter frames named Silence Insertion Descriptor (SID). This SID carries the information of the talker’s noisy background, allowing its reproduction in the receiver side. Although the size of the SID frame is small comparing with the active voice frames at the physical level, it is at the transport level that it needs to include the RTP/UDP/IP header that might generate a significant increment in the traffic generated during the silence period. It is then necessary to model the extra traffic inserted by the SID during the science period in the IP network. Then the 2- state voice activity Markov model when considering the frames transmission has the following diagram:

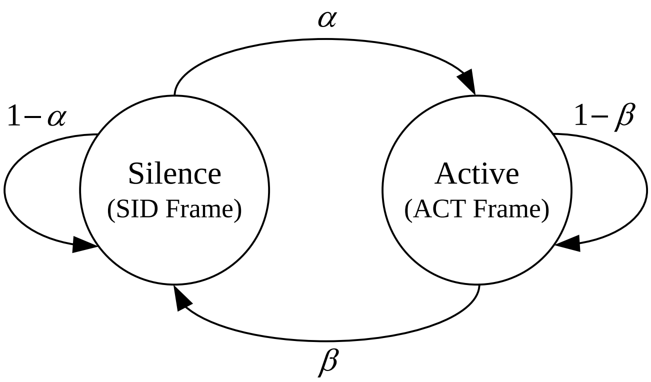

Figure 1 2-state Markov Model

3. **Mean Bit Rate of the ON-SID model**

The mean bit-rate of one conversion is the sum of the contributions of the traffic generated during voice activity (R_{ON}) and voice in silence periods (R_{SID}). Let ρ denote the voice activity rate then the bit rate can be expressed as:

$$R = \rho * R_{ON} + (1 - \rho) * R_{SID} \qquad (1)$$

During voice activity periods a new voice packet loaded with N_{fpp} frames is generated every $N_{fppN} * T$ seconds, where T is a frame period.

Then the mean bit-rate for these periods is

$$R_{ON} = \frac{N_{fpp} * L_{ACT} + H}{N_{fpp} * T} \qquad (2)$$

Where

L_{ACT} and H represent the size in bits of a voice frame and the RTP/UDP/IP header, respectively.

The mean bit-rate in the silence period can be expressed from the contributions of the header and the SID frames as:

$$R_{SID} = R_H + R_{SIDf} \qquad (3)$$

The contribution of the SID frames can be obtained from:

$$R_{SIDf} = \frac{L_{SID}}{T\,E[X]} \qquad (4)$$

where L_{SID} is the size of a SID and $T.E[X]$ is the expected inter-arrival time of the SID frame.

In considering the contribution of the packet header generated during the silence period, it follows from RFC3551 [5] that one packet header is sent for every non-consecutive SID frame and for consecutive SID frames one packet header is sent for every N_{fpp} frames. If *P1* denotes the probability of consecutive SID frames generated, then the header contribution can be evaluated as:

$$\begin{aligned} R_H &= P_1 \frac{H}{N_{fpp} TE[X]} + (1-P_1) \frac{H * N_{fpp}}{N_{fpp} TE[X]} \\ &= \frac{H}{TE[X]} \ (1 - \frac{P_1 (N_{fpp} - 1)}{Nfpp}) \end{aligned} \qquad (5)$$

Then R_{SID} is the sum of R_{SIDf} and R_H. If it is ON-OFF model then R_{SID} would be zero. By summing R_{ON} and R_{SID} we have the overall mean bit-rate in one conversation as:

$$\begin{aligned} R &= \rho \left(\frac{L_{ACT}}{T} + \frac{H}{N_{fpp} T} \right) + \frac{(1-\rho)}{E[X\}T} * \\ & \left(L_{SID} + H\,(1 + \frac{P_1 (1 - N_{fpp})}{N_{fpp}}) \right) \end{aligned} \qquad (6)$$

The parameters in the evaluation of R depend on the codec's characteristics and the number of frames per packet N_{fpp}.

4. Mean Bit-Rate Comparisons between ON-OFF and ON-SID Models in RTP AMR 12.2 Codec

The detailed parameters characteristics of the VoIP traffic model for IPv4 are listed in Table 1, and the mean bit-rates based on these parameters in either the ON-OFF model or ON-SID model are calculated and compared as shown in Figure 1 when one frame to ten frames per voice packet are generated during the active state. It is observed form the result that the mean bit-rate in using the ON-SID model is around 7.6% to 9.6% higher than that by using the ON-OFF model.

Table 1 Detailed Description of the VoIP Traffic Model for IPv4

Parameter	Characterization
Codec	RTP AMR 12.2 Source Rate: 12.2 kbps
Encoder Frame Length	20 ms
Voice Activity	40%
Payload	Active: 33 Bytes Inactive: 7 Bytes

	SID Packet Every 160 ms During Silence
Protocol Overhead with Compressed Header	RTP/UDP/IP (including UDP Check Sum): 3 Bytes 802.16 Generic MAC Header: 6 Bytes CRC for HARQ : 2 Bytes
Total Voice Payload on Air Interface	Active: 44 Bytes Inactive: 18 Bytes

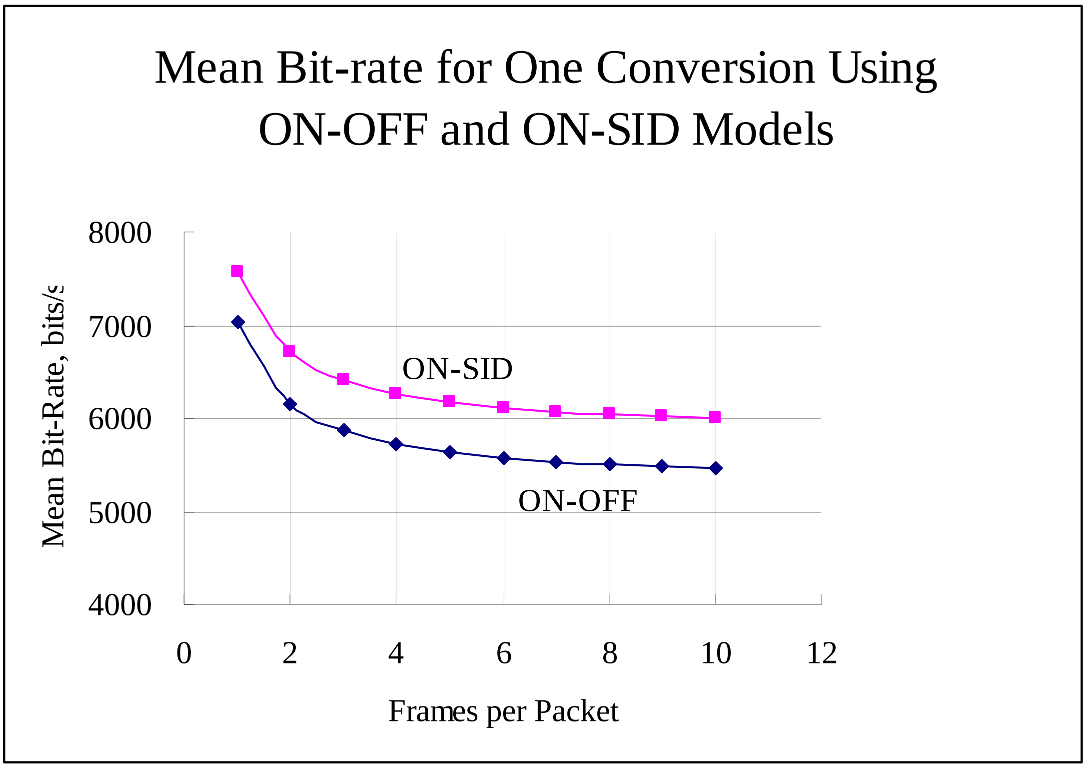

Figure 1 Mean Bit-Rate for one Conversion Using ON-OFF and ON-SID Models