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Computer Networks 50 (2006) 2676–2712

Computer Networks

www.elsevier.com/locate/comnet

A framework and source model for design and evaluation of Robust Header Compression

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Received 12 December 2004; received in revised form 25 July 2005; accepted 26 September 2005
Available online 17 November 2005

Responsible Editor: X.S. Shen

Abstract

Robust Header Compression (ROHC) is a specification being developed by the Internet Engineering Task Force (IETF) for compressing protocol headers robustly over wireless channels to improve bandwidth efficiency. Traditionally, header compression schemes are designed based on qualitative descriptions of source headers. This is inadequate because qualitative descriptions do not precisely describe the effect of different source and deployment scenarios, and it is difficult to perform optimization using this methodology. In addition, due to the use of qualitative descriptions, most studies on header compression performance do not take into account the tradeoff between performance metrics such as robustness and compression efficiency. In this paper, we present a modeling framework for header compression. For the first time, a source model is developed to study header compression. Modeling the way packets are generated from a source with multiple concurrent flows, the source model captures the real-world behavior of the IP Identification header field. By varying the parameters in the source and channel models of our framework, different source and deployment scenarios can be modeled. We use the framework to define and establish the relationship between performance metrics, offering new perspectives to their current definitions. We then introduce the objective of scheme design and the notion of optimal schemes. Based on this new paradigm, we present a novel way to study the tradeoff dependencies between performance metrics. We demonstrate how a scheme can be designed to optimize tradeoffs based on the desired level of performance.

Keywords: Header compression; Source modeling; Performance evaluation; Performance metrics

1. Introduction

Header compression improves the bandwidth efficiency over bandwidth scarce channels and is especially attractive in the presence of small packet payloads, which is often the case in practice. Interactive real-time

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1389-1286/$ - see front matter
doi:10.1016/j.comnet.2005.09.036

Nomenclature

A	Channel A packet error process
B	Channel B packet error process
b	bit parameter of (W)LSB code
BER_g	bit error rate on condition that the channel state is good
BER_b	bit error rate on condition that the channel state is bad
C	compressor process
$\overline{C}_j$	mean compression success probability for the jth code in the codebook
CE	compression efficiency
CT	compression transparency
D	decompressor process
f	a generic flow of packets
f_o	glow of observation
g	number of complicated CHANGING fields in the header
h_f	state truncation threshold; number of states in flow f of truncated model
K	number of codes in the codebook Ψ
m	length of the field in bits
n_A	number of packets transmitted by the source S to the compressor C
n_B	number of packets received by the compressor C from the source S
o_f	offset parameter of (W)LSB code
$q_{(f,j)}^{(f',j')}$	source model state transition probability, from state (f,j) to (f',j')
r	context refresh period
S	source process
U_j	probability of using the jth code in the codebook
w	size of context window; measure of robustness
X	channel state process
Y	bit error process
Z	packet error process
β_j	position of the first bit of the jth packet in a series of packets
Δ	source delta process
ε	error due to truncation in Markov model
γ_n	nth order probability distribution
η	overhead incurred in 'discriminator bits' to signal code used in codebook
λ_j	length of the jth packet
ζ	set of (w,r) pairs satisfying the desired compression transparency criterion
Ψ^K	codebook of $K-1$ (W)LSB codes with 1 fallback uncompressed code

applications like IP telephony, multi-player network gaming and online chats all generate disproportionately small payloads in comparison to headers. In addition, non-real-time applications like web browsing predominantly carry payloads no more than a few hundred bytes.

The adoption of early header compression schemes over wireless links failed because early schemes like Van Jacobson Header Compression (VJHC) [1] were designed to operate over reliable wired links. Each loss of a compressed packet caused the compressor–decompressor context synchronization to be lost, generating a series of packets discards due to corrupted packets from decompression failures. The error condition persisted till packet retransmission initiated by higher layers (e.g. TCP) restored context synchronization. Over wireless links where high error rates and long round trip times are common, this caused header compression performance to deteriorate unacceptably. To deal with this, a number of schemes like IP Header Compression (IPHC) [10] and TCP-Aware Robust Header Compression (TAROC) [9] were proposed to offer robustness against packet loss in wireless channels. The ROHC is currently the state-of-the-art header compression