Evaluation of a Generic Unidirectional Header Compression Protocol

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I. INTRODUCTION

The convergence of technologies has generalized the use of IP protocols in most network communications. Even if this generalization allows the various technologies to communicate, it implies the addition of new protocols in the protocol stack leading to more and more headers. For applications using small or medium packets (*e.g* voice over IP), the headers can represent an large part of the data. In wireless (including satellite) communications, the constraints in terms of bandwidth and loss recovery delay can largely benefit from header compression (HC) techniques which allow to reduce the size of the headers.

The main drawback of such techniques is to weaken the transmission against bit error or packet losses. Indeed, the loss of some packets can then lead to a non-decompression of the following packets headers and then to the loss of the corresponding payloads. Since wireless or satellite communications are subject to errors or losses, the HC protocols must be carefully designed.

Satellite communications can strongly benefit from HC, as any other communication means. However, some properties must be considered in the setting of the parameters of the HC protocols. First, the extremely large Round-Trip Time (RTT), roughly 500 ms for geostationary satellite (merely one second in a DVB-S/DVB-RCS scenario), can have a strong impact on the protocols using bidirectional links. Moreover, a large proportion of satellite applications does not have return link (*e. g.* DVB-SH [1]) and then can not safely use bidirectionnal compression protocols. The second property is that, contrary to some 3G-based protocol stacks, protocol stacks used in satellite communications (MPE, ULE, AAL5 and now GSE) do not allow the error bit to pass up to the link layer. Thus, the channel observed by the HC protocol is a packet erasure channel.

In order to evaluate and parametrize HC techniques on satellite communications, we need a model integrating the satellite properties. This paper proposes a first step toward this model by defining a generic model for an unidirectional link. After presenting the context in Section II,we present our model in Section III and discuss the results in Section IV.

II. UNIDIRECTIONAL HEADER COMPRESSION PROTOCOLS AND SATELLITE COMMUNICATIONS

Since unidirectional links can only use non-connected protocols, we only focus here on HC protocols for RTP/UDP/IP. Two main standardized header protocols can be used for this protocol stack: ROHC [2] and eCRTP [3].

eCRTP [3] is an enhanced version of CRTP [4] for links with high delay, packet loss and reordering. The robustness is mainly obtained by sending $N+1$ consecutive uncompressed packets after each change in a full value or a delta value, where N is a parameter representing the quality of the link between the hosts. In case of losses, the receiver tries to recover the header with the TWICE algorithm. On unidirectional links, periodical refreshes are used.

Thanks to the use of the W-LSB compression method, ROHC (RObust Header Compression) [2] is probably the most efficient HC protocol. Three compression states are defined for the compressor and the decompressor. Orthogonally to the states, the ROHC scheme has three modes of operation, called Unidirectional (U), Bidirectional Optimistic (0), and Bidirectional Reliable (R) mode. In the unidirectional mode, the transmission between the compression states, and thus the refreshes of the static and dynamic contexts are determined by time-out parameters.

Evaluations and comparisons of these protocols were proposed in *e. g.* [5] or [6], however, these papers does not integrate the RTT parameter, which is necessary to evaluate an HC parameter in a satellite context. The first step toward a model integrating this parameter is presented in the next Section.

III. MODELING AND ANALYSIS OF A GENERIC MODEL OF UNIDIRECTIONAL HEADER COMPRESSION PROTOCOL

This paper aims to evaluate the influence of the different parameters of the system on an HC protocol behaviour. For that, we define a simple generic HC model ecompassing the main concepts used by [3] and [2] on a unidirectional link.

This generic protocol simply implements periodic refreshes by sending iteratively n consecutive packets with uncompressed headers and c consecutive packets with compressed

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headers. We consider an erasure packet channel (*i.e.* the packets are either lost or received without errors) with independent losses.

The efficiency of the recovery mechanisms used (like TWICE for eCRTP or W-LSB for ROHC) is depicted in our model by $p(\delta)$, which is the probability of an header recovery success after δ consecutive losses.

The main achievement of this model is to give the output packet error rate (PER_{out}) given an input packet error rate PER_{in} (*i. e.* Frame loss rate). For this, we introduce the performance measure $\mu = \frac{PER_{out}}{PER_{in}} = \frac{n.\mu_n + c.\mu_c}{n+c}$, with μ_c and μ_n being respectively the average number of packets lost following a loss of a compressed or uncompressed packet. The methods we used to obtain these parameters will be detailed in the full paper.

Another efficiency parameter corresponds to the ratio between the average header size and the size of uncompressed headers : $e = \frac{n.l_n + c.l_c}{(n+c).l_n}$ where l_n and l_c are respectively the size of uncompressed and compressed headers.

We also study the time needed after a packet loss for the decompressor to be able to output useful data.

We give examples or results obtained with this model. Figure 1 shows the influence of c, the number of consecutive compressed headers, and the recovery performance of the protocol $p(\delta)$. Note that $p(\delta)$ was modeled by the function y^{δ}, where y varies from 0 to 1. The others parameters are fixed as follows : $n = 3$, $PER_{in} = 10^{-4}$, $l_n = 40$ bytes, $l_c = 4$ bytes, $l_p = 450$ bytes and $R = 10^5$ KBytes/s. Figure 2 shows the values of the desynchronisation time in function of the input packet loss rate (PER_in) and the transmission rate (in bytes). The others parameters are fixed as follows : $n = 3$, $c = 50$, $l_n = 40$ bytes, $l_c = 4$ bytes, $l_p = 450$ bytes and $p(\delta) = 0.7^{\delta}$.

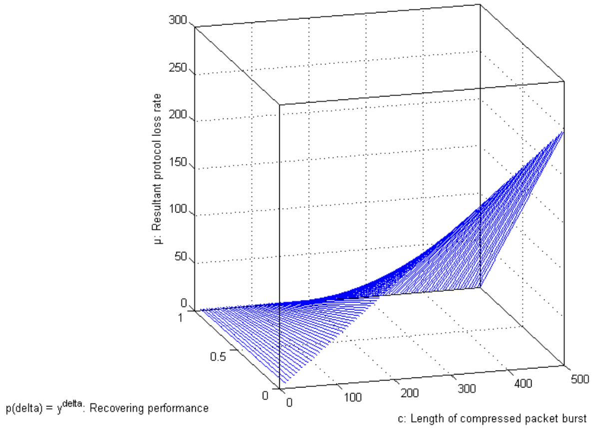

Fig. 1. Influence of protocol parameters and recovery mechanisms performance on the output packet error rate

IV. Discussion and Conclusion

Some first lessons can be drawn from Figures 1 and 2. Indeed, Figure 1 shows that, for classical parameters, the multiplicative factor (*i. e.* μ) between the input PER and the output PER can reach two orders of magnitude and then, can directly cause the mis-functioning to some applications (e.g. video).

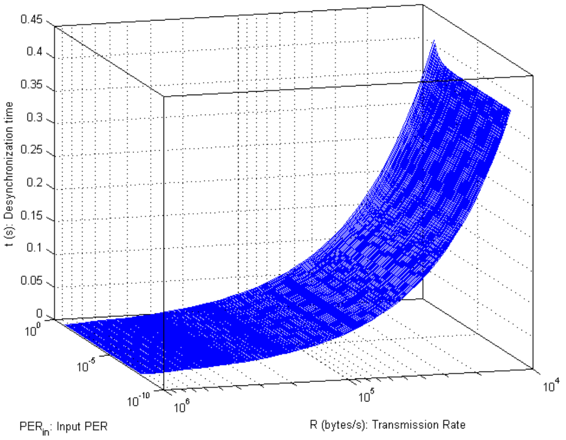

Fig. 2. Influence of PER_{in} and transmission rate on the desynchronisation time.

Figure 2 shows that the desynchronisation time is, for classical parameters, less than 0.15 seconds. This is a very interesting information in the satellite context because, for an bidirectional HC protocol using context refreshes based feedback of the decompressor (*e.g.* modes R and O of ROHC), the desynchronisation time is exactly equal to the RTT. Thus, the implication of the Figure 2 is that, for the consider parameters, a bidirectional mode is useless for satellite communications.

This work will be extended in several ways. First, the proposed two-states model will be extended to a three-states model to evaluate unidirectional ROHC. The integration of the return link, and thus of the RTT parameter, is also planned. An accurate analysis of the performance of the recovery mechanisms like W-LSB or TWICE, will also be performed. The obtained model will be then evaluated on erasure channels integrating burst losses patterns.

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