STUDYING THE EFFECTS OF FEC ON VOICE TRAFFIC USING PSQA

Martín Varela (Advisor: Gerardo Rubino)

IRISA / INRIA Rennes / Université de Rennes 1
Rennes, France
mvarela@irisa.fr

1 – Context

We study the *perceived quality* of voice over IP networks (VoIP) in the best–effort context of the current Internet. As the Internet does not provide any Quality of Service guarantee, the VoIP stream is usually degraded during transmission.

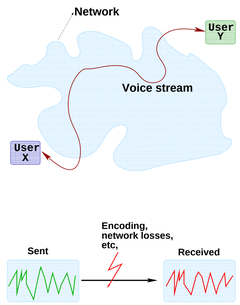

FIGURE 1: Our basic context. Users X and Y are having a VoIP conversation. The perceived quality at each end strongly depends on the encoding parameters and network conditions.

2 – Media–dependent Forward Error Correction (FEC)

In order to improve the stream quality in the presence of network losses, we can use FEC. This error correction mechanism [1] consists of piggybacking a compressed copy of the contents of packet N in packet $N + i$ (i being eventually variable in order to compensate for variable loss–burst sizes).

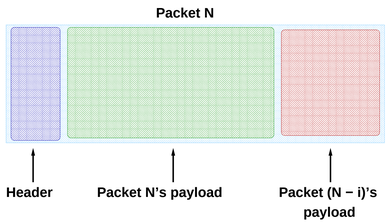

FIGURE 2: A packet carrying its own payload, plus a compressed copy of a previous packet's payload. If packet $N - i$ is lost, it can be reconstructed from packet N.

3 – PSQA: Assessing the Perceived Quality

VoIP quality is a subjective concept. Therefore, the preferred mechanism for assessing it is the *subjective test*, in which a group of human subjects evaluate a series of streams according to their own notion of quality. The output of these tests is normally a Mean Opinion Score (MOS), and it is widely accepted as the "real" quality. However, these tests are very time–consuming and expensive. Other solutions (*objective tests*) have been proposed, but they generally don't correlate well with MOS values. We have recently proposed a hybrid approach [2] based on Random Neural Networks (RNN), which we call Pseudo–Subjective Quality Assessment (PSQA). The RNN is trained with the results of a subjective test, and it can then provide good results (that is, close to real MOS values) for a wide range of encoding and network conditions.

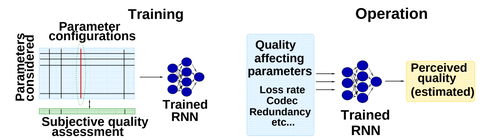

FIGURE 3: PSQA. The results of a subjective test and the parameters used to create the tested samples are used to train the RNN. The trained RNN is then able to predict the perceived quality based on measurements of the parameters considered.

4 – The Impact of FEC: Wired Networks

In order to evaluate the impact of this technique on the perceived quality, we used a $./M/1/H$ 3–class queue to model the network, and studied different scenarios to see how the increase in load produced by FEC affects the network state (this work is an extension of [3]). We found that FEC provides a marked improvement in all of the conditions considered. Even if its performance decreases as the network load increases, it still allows for a better quality than no protection at all. Moreover, the increase in network load caused by the use of FEC has a negligible impact on the overall perceived quality, which means that there is no reason not to use FEC in the context considered.

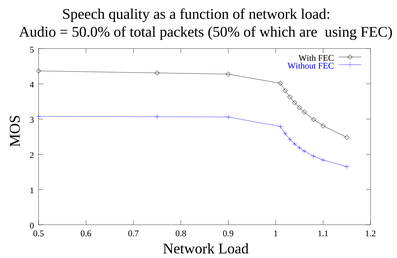

FIGURE 4: Evolution of the perceived quality as the network load increases. In this scenario, 50% of all packets correspond to audio flow, and of those, half are using FEC and half are not. Note that MOS values range from 1 to 5, and 3 is considered acceptable quality.

5 – The Impact of FEC: Wireless Networks

We have also analyzed the performance of FEC in a wireless context. We considered a home network where several devices are connected to the Internet and among them via a *wi–fi* AP/router. We used a stochastic model to simulate the *wi–fi* network working at different loads and with different fractions of background and real–time traffic. We found that the performance is generally not acceptable for VoIP, even when using FEC. In this context, further QoS mechanisms and dynamic quality control techniques need to be used.

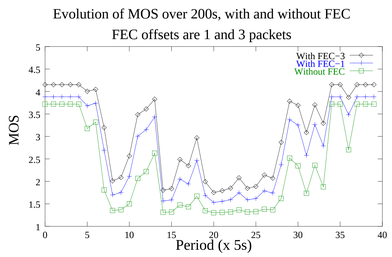

FIGURE 5: Evolution of the perceived quality over a 200s period (measured at 5s intervals). In this scenario, 50% of all packets correspond to audio flow, and of those, all are using FEC. We can see that even using a higher offset to counter the higher mean loss burst sizes that occur in this context, the quality falls below acceptable levels.

6 – Conclusions and Further Work

We have performed an analysis of the performance of a media–dependent FEC scheme on wired and wireless networks. Based on the results we obtained, we conclude that:

- The use of FEC is advisable in all the contexts we considered.
- For wired networks, the use of FEC allows to obtain acceptable quality levels even for very high load values.
- In the case of *wi–fi* networks, even though FEC–protected flows have a noticeable better quality than unprotected ones, the perceived quality is often below acceptable values. This suggests that further QoS mechanisms are needed in this context.

We are currently working on several related issues, including:

- The development of dynamic quality control mechanisms based on PSQA's ability to provide accurate assessments in real–time. We are considering several options for enhancing the perceived quality, ranging from application–level adjustments to DiffServ.
- Refining our wireless simulations to include the 802.11e QoS improvements and the impact of the control protocols that we are working on.

References

[1] J-C. Bolot and A. Vega Garcia. The case for FEC-based error control for packet audio in the Internet. In *ACM Multimedia Systems*, 1996.

[2] G. Rubino, M. Varela, and S. Mohamed. Performance evaluation of real-time speech through a packet network: a Random Neural Networks-based approach. *Performance Evaluation*, 57(2):141–162, 2004.

[3] G. Rubino and M. Varela. Evaluating the utility of media–dependent FEC in VoIP flows. In *Proceedings of QofIS'04*, Barcelona, 2004.