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Title: QoS metrics for Data modems over packet-based connections

Abstract

Two metrics for use with data modems for VoIP, VBD and other packet-based modes of operation are suggested.

Introduction

Various metrics have long been used to describe or alert system operators of the Quality of Service that customers are experiencing based on any number of real-time and aggregate statistics. In general, they predict how customers think their calls sound, most often using some version of a Mean Opinion Score, or MOS.

With the advent of PSTN gateways, IP Phones and other such devices that route traditional PSTN traffic over the Internet and other packet based transport systems, any and all uses of telephone lines have crossed over into the packet realm as well. Because customers use these new “telephone lines” as they do old ones, they expect similar performance for connected data devices as they had with PSTN lines. There is however no consistent way of predicting performance of these devices like there are for voice calls. Here we begin a discussion of two such measures.

Perception of voice quality versus fax and data quality

Many years of study have shown that although various factors degrade voice connections, there is a range of quality in which the user will be satisfied for the most part with their service. In fact, when mobile phones are considered this range can be quite wide because of expectations.

In general, a customer will consider a phone call a “success” if the interconnection is sufficiently good to communicate freely, and fairly easily. In addition they want to end the call when they are finished with the conversation. For example, even though quality is generally lower for mobile phones, customers tend to accept it with out major complaint until call drops become a problem. Even having to re-establish a call after a drop in order to complete a conversation is not considered a failure.

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With data communications however, any call that ends before the user wants it to is a complete failure. The dial-up Internet user will become quite frustrated quite quickly if his connection regularly drops. The same is true for fax users. Delays due to numerous attempts to transmit a document via fax are unacceptable. For these reasons, any call that drops would have to rate extremely low on any scale.

Throughput Index

A companion contribution notes that, as expected, increasing packet loss in networks carrying data traffic decreases data throughput. However up until the point that data connections fail, data is passed along in the connection. Based on basic packet loss rates, and other statistics of packet loss (burstiness, randomness and so on) and with some knowledge of modulation types, a reasonably accurate prediction can be made on any VoP (Voice Over Packet) call of approximate throughput that is scalable by modulation type. Potentially such an index could be on a scale of 1-100 meaning a percentage of nominal throughput that could be expected over a VoP channel should a data call be attempted.

Reliability or Longevity Index

As discussed before, the termination of a call other than by the user is deemed a failure. However, modem and data calls are not open-ended. This is especially true for fax calls where average faxes rarely run more than a minute or so, or in PoS (Point of Sale devices such as credit card verifications systems) devices when data exchange can be completed in a matter of seconds.

A second metric that predicts the likelihood that a modem or fax call will be dropped due to network impairments can be developed that suggests the possibility that a particular call will survive for the next X number of minutes or seconds. In the case of fax and PoS, this metric could accurately predict the success or failure of these transactions in conjunction with the throughput index and basic assumptions about usage.

Again a metric with a scale of 1-100 is suggested, either for the next predetermined amount of time or if the call will survive until the user is finished.

Usage

Service providers are being increasingly asked to provide fax and data metrics in addition to voice metrics as terms of Service Level Agreements. Metrics such as these could provide a means for providers to gauge the potential of various connections should a data call be made. It could then be used to “harden” lines provided specifically for or in addition to voice service for fax and data.

Tests

In tests to date, our implementation of metrics based on the above criteria, have shown a very strong correlation between predictions and actual results, especially throughput. Unlike subjective testing, these metrics have only a very objective component and are therefore quite repeatable.

As mentioned in the companion contribution, packet capture files were obtained for numerous connections for a wide range of impairment levels. Implementation of the throughput index proved to be in general less than 10% off from actual measured values when run against the capture files of these test connections.

Figure 1 displays a prediction of data throughput plotted against packet captures of data sessions and actual measures of throughput. Ideally, the trend line would line up with the equality line. The data plotted has an average 9.99% prediction error.

Note the 6 outliers above the trend line. In almost all of these instances where the actual throughput was noticeably lower than the prediction, the modems had connected at something other than maximum speed.

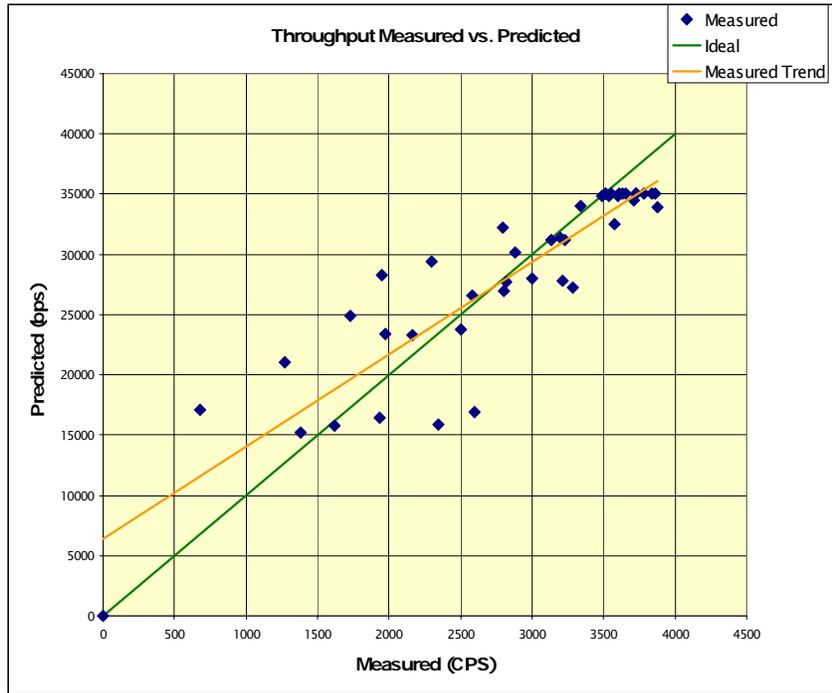


Figure 1 - Throughput prediction and measured data.

The reliability index, also implemented also fairly accurately predicts that calls will or will not fail, as well as a general time frame for the longevity of the calls. Because the length of calls even in consistent impairment conditions varied greatly, the second of these two predictors has a larger margin of error than the throughput index.

Summary

The fax machine and the data modem will not vanish in the near future. And as more and more PSTN-like traffic is moved to packet-based networks, some method of predicting how well these devices will function (or not) in these new environments is becoming increasingly important. This paper suggests a starting point for the development of such measures.

References

- [1] COM 12 – D 95, Geneva 17-21 October, 2005, Telchemy Incorporated. “Behaviour of data modems in lossy, packet-based transport systems”