LIMITATIONS FOR MEASURING PACKET LOSS PROBABILITY USING ACTIVE PROBING TECHNIQUES

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Abstract: Performance measurement of packet (e.g. managed IP) networks is a vital element in the commercial viability of broadband networking. Active measurement techniques in which probe packets are injected into the network have a great potential as the probes can be accessed across network boundaries. We apply our simulation results to show that when using probing packets the same size as the data packets the average time until a probe is lost due to an overflowing buffer can be very large and may make probe based SLA monitoring extremely difficult. Furthermore, this paper also concentrates on the trade-off between accuracy and packet probing overhead.

1. Introduction.

IP networks are evolving through the interconnection of separate networks, and this (among other factors) is encouraging the use of measurement by active network probing. Furthermore, modelling of emerging multiservice packet networks, including the packet backbones for 2.5G and 3G mobile networks, is based on the network's ability to guarantee QoS to user applications [1].

For measurements to accurately reflect any network's performance, they must be carried out over the periods when customers are active, else the delays and loss probabilities could be averaged over virtually unloaded periods, and would not then reflect the real experience of most customers. For this reason we adopt the notion in [2] that measurements should be carried out over a busy hour. We use this fact, and the allocated probing rate to calculate how many probed samples are available to measure the loss probability.

Recent studies have focussed more on active probing for network delays [1,3]. It has been shown that for bursty, but still Markovian (i.e. Short Range Dependent (SRD)) traffic patterns, measuring the mean end to end packet delay can require an impracticably high proportion of the link bandwidth. In [4] it was established that the probe packets have to be substantially the same length as the data packets: if this is not the case then the measured loss probabilities will be wrong by many orders of magnitude. It was not established in [4] whether probing for loss was actually possible. In [5] we investigated the potential effectiveness of using probes over single access links and evaluated the mean time to encounter an overflowing buffer. In this paper, we further investigate the probing accuracy.

2. Simulation Studies.

There are two steps to consider when probing for packet losses. First, what size probes are needed to detect loss? This has been shown in [1] where the probe packets used were (roughly) equivalent in length to the data packets. Secondly, how many probes are required to detect loss? In order to find out the number of probes required until an overflow is experienced, we investigate the expected time until a probe encounters an overflow.

Multiple On/Off Exponential sources were used since they are the standard model for VoIP traffic, and multiplexed into a FIFO queue. The simulation tool used for the scenario was ns2. Packet sizes of both 40 and 100 bytes were used and in both cases the probes and the traffic had the same packet size. We use a single access link, with a fixed link rate. This is the main bottleneck and is investigated with varying load values using the following simulation parameters:

T_{on} = mean ON time (seconds) for an individual traffic source = 0.96 sec
Toff = mean OFF time (seconds) for an individual traffic source = 1.69 sec
h = ON rate of an individual traffic source = 64 kbps

A buffer will go through a number of cycles where each cycle consists of an overflow period followed by a non-overflow period. Figure 1 shows the mean overflow (A secs) and the mean non overflow periods (A' secs). Tcycle is the mean of one complete cycle for overflow and non overflow periods.

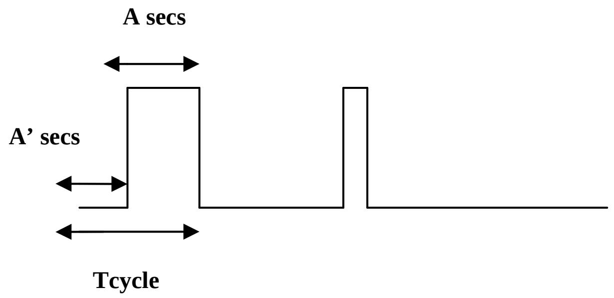

Figure 1: Tcycle: sum of the overflow and non overflow periods

We modelled the number of packets lost in an overflow period as a geometric distribution as shown in [6]. This is demonstrated by the reducing mean overflow periods in figure 1. Tcycle can be used as an upper bound on the non-overflow period to encounter (with a probe) an overflowing buffer. We have an average Tcycle until the next overflow period starts.

It is the key to this study that as the buffer utilization increases (i.e increasing load), so must the buffer length in order to ensure that the packet loss probability (PLP) remains constant. It must be kept constant as it is the target we are trying to achieve for a particular networking scenario. In line with the recommendations in [7], we chose a target PLP of $1\text{x}10^{-4}$.

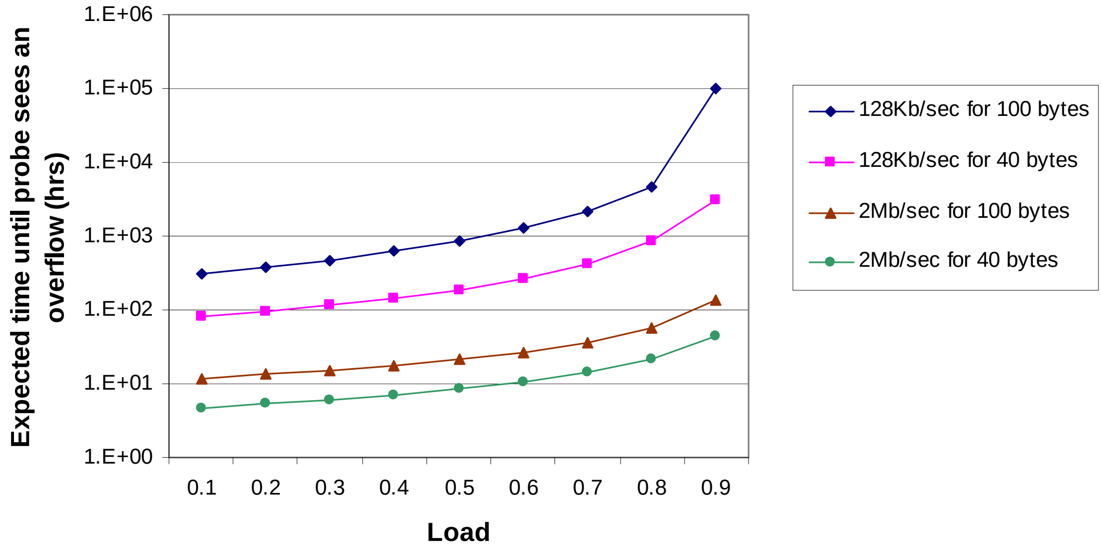

Figure 2: Comparison between the expected time until a probe encounters an overflow with 100 and 40 bytes

Figure 2 shows the comparison of the expected time until a probe encounters an overflow using 100 and 40 byte sized probe packets for varying access link rates. It also illustrates that for increasing loads, the time taken for the probe to observe an overflow also increases. This is because we have increased the buffer length with increasing load to maintain our target PLP. Furthermore for decreasing access link rates, the time taken to encounter an overflow period is very large. Moreover, it can also be seen that the smaller probe size requires less time to encounter an overflow.

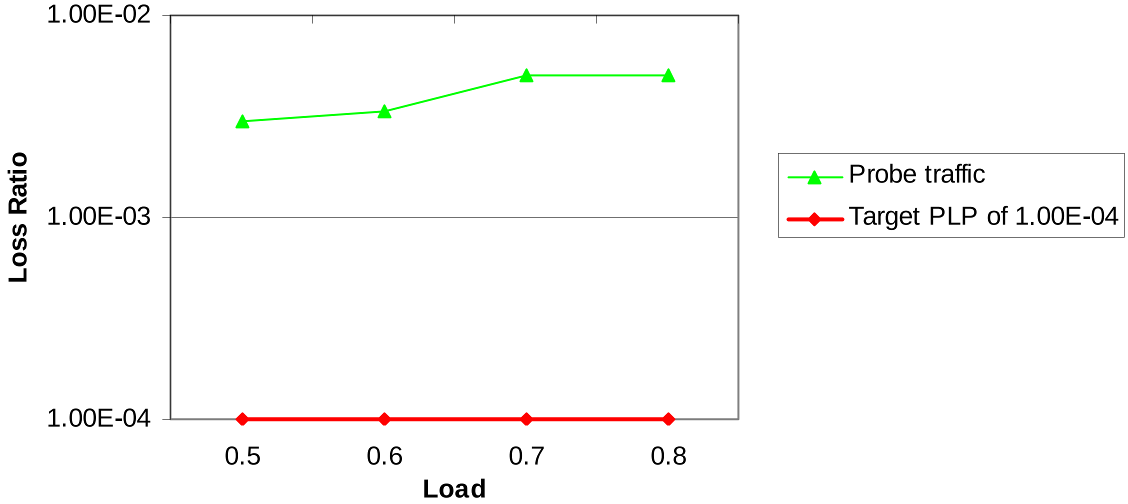

Figure 3: Effect of Probes on the data traffic for 40 bytes packet size

Figure 3 compares the probes experience of the loss probability to our target PLP of $1x10^{-4}$ over a 256Kb access link. The probe packet size used is 40 bytes and the probing (or sampling) rate is kept at the Cisco SAA default of 1 probe/sec. In order to measure during periods when most users are active (i.e busy hours), we used the recent recommendations from Cisco Systems [2] that measurements are carried out over busy hours. This also gave us the number of measurement probes used.

Since the packet size used is very small and the VoIP traffic is not that bursty, it can be seen from figure 3 that probing tends to be quite accurate. However, this may not be the case for burstier and larger packet sizes as it may significantly increase the bandwidth overhead [8]. This implies that a very large number of probes maybe used to achieve the required level of accuracy.

3 Conclusion.

The use of active probing has been studied against a standard model of VoIP packet traffic. We find that the mean time until a probe sees an overflow is dependant on load. For higher access link rates (2Mb/sec), it takes less time for the probe to see an overflow. Furthermore, smaller probe size requires less time to encounter an overflow compare to larger probe size.

For accurate measurement, the probing rate can be increased, which requires an increase in bandwidth and leads to higher packet losses.

Although the access link analysis indicates the main challenges faced, but the situation maybe worse for an end-to-end network. Furthermore, if the traffic is burstier than VoIP, or requires lower packet loss probability, the mean time until measured loss events will be increased.

4 References

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