LIMITATIONS OF PASSIVE & ACTIVE MEASUREMENT METHODS IN PACKET NETWORKS

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Abstract: Measurements and simulations are the main tools for studying the performance of IP networks. Furthermore, active measurement techniques are becoming an integral part of real network performance management systems. But if excessive testing packets are generated and injected into the network, then it might lead to worsening congestion. However, passive monitoring of queue length distributions will not cause any intrusive effect to the network, but it may not be scalable. This paper will explore the limitations of passive and active measurements and provide some measurement results related to them.

1. Introduction.

Managed IP networks have become a dominant factor in bringing information to users on a worldwide basis. Until recently, IP networks supported only a best effort service. This limitation has not been a problem for traditional Internet applications like web and email, but it does not satisfy the needs of many new applications like audio and video streaming, which demand high data throughput capacity (bandwidth) and have low-latency requirements [1]. Thus, it is becoming increasingly important to provide Quality of Service (QoS) in managed IP networks.

Performance of a network can be measured using end-to-end delay probability and cell loss probability (CLP). Active and passive measurements are the two fundamental approaches used to measure performance in IP networks. The former injects testing packets into the network while the latter non-intrusively monitors the traffic by using access to the buffers in the routers.

The main goal of this paper is to evaluate the limitations of active and passive measurement. In section 2, active and passive measurements are introduced and discussed. It also demonstrates the problems that arise using active and passive measurement and outlines a possible combination of the two. Finally, the last section concludes the paper.

2. Measurement of QoS in IP networks.

The performance of a network is of vital importance to both the service providers and the customers. Performance can be measured with parameters such as bandwidth, delay, jitter and loss. Currently, there is no standard for the QoS performance measurement, hence various methods are used: actively by insertion of test traffic, or passively by observing user generated traffic.

2.1 Passive Measurements.

Passive measurement is a means of tracking the performance and behaviour of packet streams by monitoring the traffic without creating or modifying it. Passive measurement can be implemented by incorporating some additional intelligence into network devices to enable them identify and record the characteristics and quantity of the packets that flow through them. Packet statistics can then be collected without the addition of any new traffic. The level of detail of the information collected is dependent on the network metrics of interest, how the metrics are being processed and the volume of traffic passing through the monitor device. Examples of the types of information that can be obtained using passive monitoring are: [2]

- Bit or packet rates
- Packet timing / inter-arrival timing
- Queue levels in buffers (which can be used as indicators of packet loss and delay)
- Traffic / protocol mixes

However, Leung et al [3] proposed a new methodology for QoS measurement and prediction. This method requires no traffic intrusion, has low overhead and reasonably low complexity of implementation.

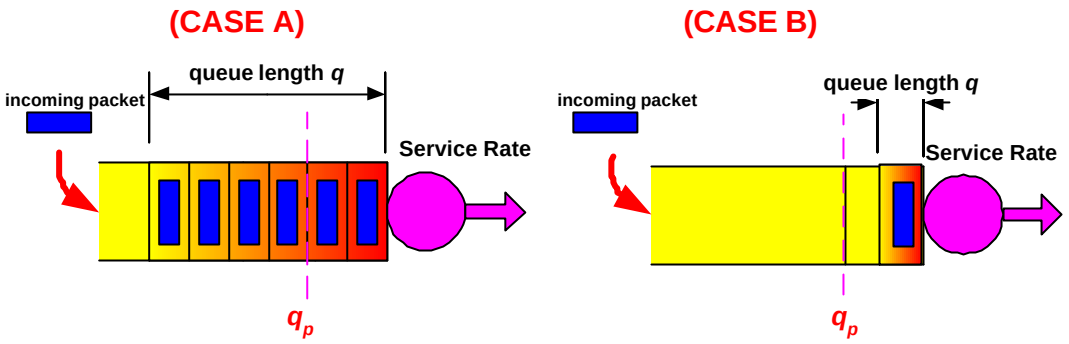

Figure 1 [3]

In Leung's method, the partition point, q_p (figure 1) was used to identify the measurement condition. During measurement, for every incoming packet, the current queue length was measured and compared with the partition point q_p. He showed that if the current queue length q, was larger than q_p. (CASE A: figure 1), then q_{high} and $freq_{high}$ would be updated otherwise q_{low} and $freq_{low}$ would be modified. The purpose of setting the partition point for the measurement is to separate the measurement for the packet-scale and the burst-scale region. According to his simulation results illustrated in figure 2, as long as the partition point is located in the burst-region and sufficient observation is taken in the *queuehigh* region, then the estimation for the decay constant and the decay rate for burst-scale region will work very well.

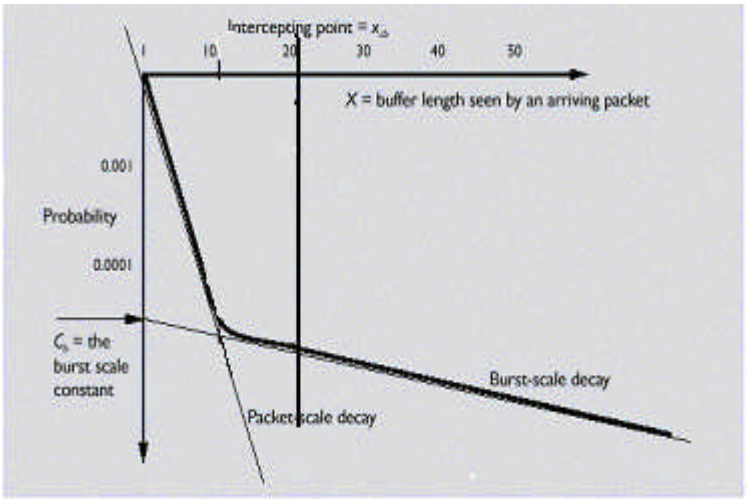

Figure 2: Typical characteristic of queuing behaviour (by simulation)

2.2 Limitations of Passive Measurements.

Passive measurements are carried out by observing normal network traffic and as such do not disturb it. Leung et al simulation results [3] were accurate thereby illustrating the non-intrusive and scalable measurement methodology for the queue length distribution inference, but the main drawback of using this passive measurement is that he assumed that he "owns" all networks.

2.3 Active Measurement.

Active measurement is another way of measuring network performance and it involves the injection of some probe packets into the network from which the relevant metrics of the probe traffic can be measured. The sole purpose of probe packets is to provide some insight into the way real network traffic is treated within the network. The type of network metrics derived using active measuring, are: [2]

- Delay
- Loss
- Jitter

One of the advantages of active measurement is that it does not require full access to network resources. (e.g. routers)

2.4 Limitations of Active Measurement.

A limitation of active measurement is that it may disturb the network by injecting artificial probe traffic into the network.

An On/Off Source Model was implemented with a FIFO queue with the following parameters: Mean on = 9secs, Mean off = 2 secs, Arrival Rate = R =2 and Service Rate = 1. The delay of the network before the injection of any probe traffic is shown in Figure 3:

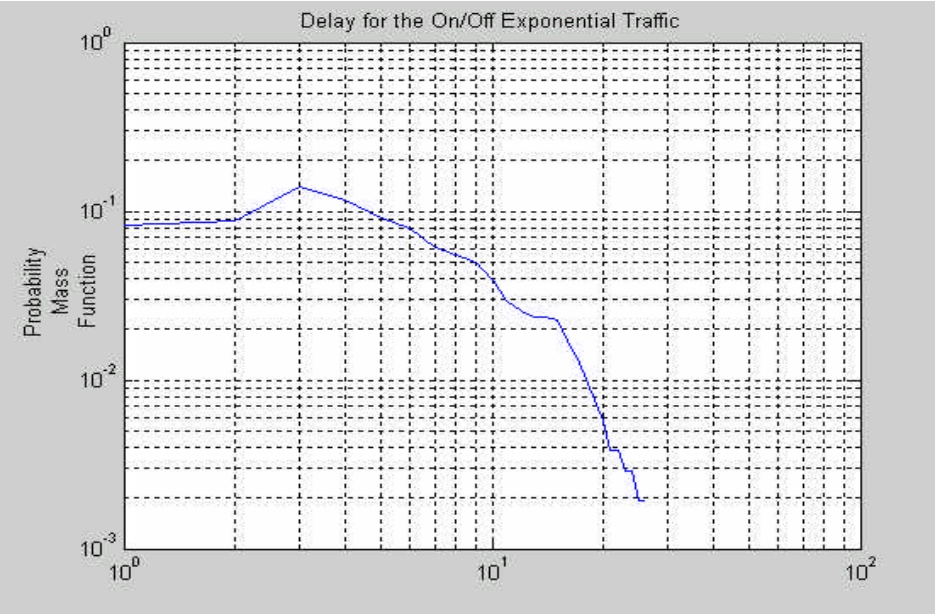

Figure 3: Delay for the foreground traffic

The pattern in which the probes are sent into the network is important and currently I am working on the way the probe traffic is sampled and sent into the network. However, the problem arises whether it is the number of probes or the time over which the measurements are taken that is important. For example do we get the same results probing for 100 seconds with 10 probes per second (1,000 probes) as we do with 100 probes per second for 10 seconds? If this is the case then some compromise could be reached with respect to the length of time measurements that are taken and the rate used to probe the network. Using higher probe rates does enable accuracy to be achieved earlier, but this disrupts the traffic. [4] Furthermore, it is the number of probes that are put into the network that is of prime importance.

The most significant one amongst the Internet Engineering Task Force (IETF) is the Differentiated Services Architecture (DiffServ) where delay sensitive traffic (eg voice) and loss sensitive traffic (eg

email) can be conveyed by higher priority class and lower priority class respectively.[5] Thus, it is required to probe each class. In order for active measurement traffic to accurately measure a particular class of traffic, measurement packets must be classified and handled the same as the traffic they intend to measure. Hence, it is better to use the same size for both the probes and the data packets.

3 Conclusion.

In this paper, we have discussed the limitations of active and passive measurements scheme. Passive measurements are accurate, scalable and have low overheads but it does not have access to own the network. On the other hand, active measurements do not require owning the network and thus do not need to pull the statistics. But unlike passive measurements, by actively injecting packets into the network may significantly affect the overhead of the bursty traffic due to the unrealistically high number of probes. Further works are being carried out to investigate statistical techniques for reducing the bandwidth overhead when using active probing and thereby combining active and passive measurement techniques.

4 References

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