Network-in Quality the E-Business

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Abstract

Recent advances in user access technology enables the delivery of Network multicast to residential users. In order for such a service to be successful, efficient management must be performed in order to cope with a large and dynamic quantity of users.

In this paper we investigate a practical monitoring scheme based on statistical control of quality of for such a purpose. We address the issue of when to trigger management actions, by formulating the problem in terms of quality of control.

Our work is targeting an efficient network monitoring entiy with a larger management platform.

Keywords: Quality, Multicast, Network Quality.

1.Introduction

The goal of this paper is to develop a monitoring scheme for multicast communication. We are interested in detecting changes and unusual behavior of multicast traffic.The purpose of such a scheme is to be used in a multicast monitoring tool that is currently under development . We investigate in this paper the potential applicability of statistical control of quality in monitoring packet loss.

The paper is structured as follows; A brief introduction to statistical control of quality and its usage in monitoring is given in section 2. The broader context of monitoring multicast sessions is given in section 3.Next,we illustrate its usage on real data and show how temporal patterns and trends can be put into evidence in section 4.section 5 shows a prototype for monitoring that is currently under development.

2.Quality

Simply stated, statistical quality control(see[2],[6],or[7]for good and comprehensive introduction to quality control)is a graphical ,quantitative method for demonstrating that a process is operating in a controlled state, or simply, “in control”. This graphical display is performed by a control chart. Control Charts who clearly and graphically how a process is behaving over time. The central theory is that the performance of any process can be described as a combination of predictable, Norman events and unpredictable, abnormanl events. These lead to acceptable or unacceptable outcomes. The predictable events are acceptable and the unpredictable events are not. Control charts allow managers to easily separate the predictable events from the unpredictable, and to respond only when appropriate.

Most processes Produce some variation. When the variation Becomes too great, this is an unpredictable. Unacceptable event which a manager must respond to.
On the other hand, variation that is within a predictable, acceptable range should not be responded to.

3. Context

Management approaches for multicast management can be differentiated by the following:

1. The management domain. Is the approach proposed to be used intra-domain or inter-domain?
2. The technology. Does it rely on SNMP, on application level information or on a specific tool? Several approaches considered the monitoring of multicast by relying on application level date like the Real Time Protocol to collect multicast data. In fact they will use the RTCP(Real Time Control Protocol). The control protocol acccomanying the RTP (Real Time Protocol), in order to learn the membership information of one group. Once that application level information is obtained. They will use mtrace (the multicast version of the traceroute utility) to infer the multicast tree topology. The mtrace utility works by tracing the path from individual receivers upstream towards the source. Routers located on the path from the receiver to the source are supposed to answer a particular type of requests. It has been shown that such an approach might not be adequate when the same session is monitored by several Mhealth tools. A second inconvenient of this approach consists in the high workload of routers located close to the source since they have to reply to requests concerning almost all receivers.

3. Is the approach active or passive? Active management approaches will inject traffic and collect accurate statistics paying however the price of additional dummy traffic in the network, whilst passive approaches will monitor real traffic and estimate some information.

Another interesting research issue concerns the qualitative and quantitative evaluation of a global multicast session. Dynamic multicast groups will have varying membership such that a measure describing the global features of a multicast session in needed.

This measure should scale up gracefully with the size on the membership and be relatively independent of small variations in this size. One potential solution to provide such a measure could be based on regions of acceptable service. In this paper we consider the statistical process control techniques as a mean towards such establishing such regions.

More specifically. We propose the introduction of quality control charts for monitoring packet loss in multicast sessions.

4.Control charts

the proposed monitoring scheme work as follows: for a particular unicast or multicast communication, control packets will be inserted periodically by the sender. The sequence numbers lf these packets are recorded at the receiver side. We consider that a particular control packet was not received if either it arrived out of order, or its sequence number is not recorded at the receiver side. We can consider the communication process to be a packet its sequence number is not recorded at the receiver side .we can consider the communication process to be a packet producing factory, such that received packets are “good”, whilst missing one are “defective”, control packets correspond to sampled packets. it is the purpose lf this section to develop a monitoring scheme based on already proved statistical toots able in order to allow for efficient management .

the basic idea is to display quality characteristic that has been measured or computed from a sample versus the sample number or time. the chart contains a center line that represents the average value lf the quality characteristic corresponding to the in-control state .two other horizontal lines, called the upper control limit (UCL)and the lower control limit (LCL)are also drawn. these control limits are chosen so that if the process is in control, nearly all of the sample points will fall between them .As long as the points plot within the control limits. the process is assumed to be in control ,and no action is necessary.

However, a point that plots outside of the control limits is interpreted as evidence that the process is out of control ,and investigation and corrective action is required to find and eliminate the assignable causes responsible for this behavior. the control points are connected within straight line segments for easy visualization. More formally: let x_i be a two valued process (possible values 0,1) such that its value is 1 iff the I-th .control packet has been received and 0 otherwise. An aggregated measure of this process is obtained by considering n successive values and counting the proportion p of os (in terms of quality control, these value correspond to the proportion of defective attributes).the resulted proportions p’s form a new stochastic process $p_i^{i=1.k}$ indicating the average proportion of missed control packets.

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We considered it worthwhile to work on the same datasets in order to allow for a comparative study of our results with the ones established in the above mentioned work.

4.1 Charts for Unicast vs .Multicast

The first experiment considered the dataset 1.we used a sample size of n=250,and Ato be equal to 2.the result is shown in this figure. We can see in this chart that the process ran out of control somewhere within the 41 and the 61 sample. in this time interval management action would have been required .for both cases. sender, receiver and monitoring time coincide.

The upper control line is significantly greater in multicast (0,05<0,06).secondly the center line for multicast is greater in multicast (0,10>0,02) A simple t-test proved that these differences are statistically significant. this shows that packet loss in multicast is different and management tools using this

information should be tuned differently with respect to unicast vs .multicast demanded only one management intervention, whilst multicast would have required four.
Monitoring the multicast/unicast communication is performed by analyzing the araph and detecting patterns or trends. Before doing an experimental analysis we should first determine the temporal behavior of the underlying process, that is identify the temporal dependence of the two processes. we compute the autocorrelations at different time-lags for the two processes .this computation is performed over the whole dataset (not only the first 100entries).

In the unicast case ,significant temporal dependence is identified up to the 14 autocorrelation coefficients which are statistically significant at a 95%level.

For the multicast case ,things are different. on one hand ,significant temporal dependence is identified up to the 24 time lag .this means that packet loss for this type of communication has a long lasting behavior. in terms of chart monitoring ,we need to look for patterns spread over 24 successive thme epochs in order to identify changes and patterns .the autocorrelations, decreased monotonically. This is no more true for the multicast .in this case . it seams that the decrease of correlations between successive time epochs is much more slower being almost piecewise constant.

4.2 Interpreting a control chart

In order to ease the presentation we consider only the first 50 samples from the multicast session. We suppose that a network management application located at the receiver side is monitoring the sampled process and applying a set of rules in order to detect significant changes in the process.

The first and second rules are used to detect statistical outliers (ie, data that somehow doesn’t fit). This can be the case in monitoring errors or out of order received control packers. In our case we identify 3 such points, located around the 4th., and 37th.. epoch.
In all these cases, the process was below LCL.
Even though having a low packet loss could be considered very desirable, in terms of quality control, this feature indicates an out of process condition.

Rule 3 helps identify regions of the process, such that significant statistical difference is exhibited among them. In our case, we have two such possible regions. The first one is located between epoch 13 and 25, whilst the next one is located between the 25th. and 40th. time epoch.
Actually, the first region is an out of control region (most values situated above the UCL).

Rule 4 indicated that a continuous change (ramp) is occurring in the data. It can be applied in the 4 th. to 13 th. epoch interval, and may help to predict the our of control region that follows.

4.2.1 Outliers
Another type of scenario is illustrated in this figure, Here, we can distinguish two major regions in the evolution Up to the 19 th. time epoch, the process seems to slowly shift in average, followed by an abrupt peak, and a further decrease.

such a scenario, we can conclude, using Rule 2, that the observed peak is not an out-of control case. Probably, some control packets were received our order, and their recording discarded. The global evolution suggests, that this outlier should be discarded, and new control parameters (LCL, UCL, and Center Line) be established.

An outlier in statistical theory is either erroneous measurement (due to faulty measurement equipment), or an indication of a sample which is not in concordance with the global process.
We can deal with outliers in two ways. If control limits (UCL, LCL and Center Line) are established by management, then the outlier will not saffect the computation of these entities, This is the case for instance when the process is monitored in order to verify that service levels are met. In this case, the outlier can be neglected.

If however, the limits are established through unsupervised process monitoring, that is, the purpose of monitoring is not related to verifying service levels, but just to make sure that no out-of-control behavior is present, then discarding this outlier is needed.

4.2.2 Time dependent charts
If we compare the two charts than we observe:
1) Each chart is better tuned for the particular network conditions, In the second region, the resulted UCL is equal to the Control Line (Center) of the first region, That is, the average values that are normal in the first case, can be considered as extreme in the second.
It doesn't mean that the process was out-of-process in the original chart, we are just able to better tune our tool in order to control the process and detect future changes.

2) In both charts, the process is stable, that is no decreasing/increasing trend is observable.
This splitting can be done online, that is new charts better suited for particular time moments can be computed whilst the management process is running. Automatic tests in order to detect when to compute a new charts can be done in several manners. In the first one, we can do it every k time-epochs.

The value k is for instance 30, if we know that the autocorrelation coefficients are not statistically significant for values greater than 30.
Other approaches for detecting moments of change can be based on on-line statistical tests of change (change point tests).

5. The multicast monitoring tool

This Java application is based on the Koala toolkit and represents the topology and ongoing communi9cation within a management domain. With respect to other graphical displays of multicast trees, that we have compared with, our tool is ergonomically better, allowing for a larger variety of user customization.
A screenshot from the GUI is shown. Management actions are invoked just by clicking on the map. The Koala toolit allows the use of several views. In the above mentioned figure three view are defined, covering different areas of the map at different zoom scales, This permits to zoom in where network topology is dense, or where detail is needed, without having to do it for the whole map. Dragging network components in the display is also possible, easing the task when working with large networks.
The figure shows the network topology situated in the immediate vicinity of our campus network.
A manager will use this GUI in order to invoke management actions and visualize the network. Management actions are invoked on the GUI and then forwarded to network.

6. Conclusions

We have introduced an analytical method for monitoring unicast/multicase communication. The method is based on statistical control of quality. Control packets are inserted in the traffic, and their loss is recorded by the receiver. A chart based test is developed in order to estimate when to perform control. Which in our case translates to management actions. This test allows to trigger management actions only when needed and avoid an avalanche of actions that could affect the service.

The charts include a baseline average line, and control limits, The control limits act as alarm values, If a performance measure datum point falls outside of the control limits (or other significant changes are detected using the other criteria listed above), then this is a significant event, which demands investigation and action. To reinforce this idea, it is useful to document the “owner” of each performance measure and what management decisions have been made or will be made based upon this measure, Such an approach could serve as a tool for monitoring SLAs of multicast delivered traffic. A SLA established with an end user could be based on a chart (specification of the LCL, UCL, and Center Line).

We applied the method on logged data and illustrated some type of usage, In the present work we have investigated only the potential to detect anomalies in the process for real date. In order to better study the potential of control charts in multicast communication we need also more data containing both recorded data and fault evidence (if any) to correlate the charts with faults and network conditions.
This would allow to build a new set of Rules that can be put into direct relationship with observed

network conditions. The next step consists in chart aggregation, that is, to build a global process chart based on packet loss information received from several monitoring agents.

Future work will consist in refining a set of efficient rules and including the proposed method in a multicase monitoring tool that is currentyly under development.

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