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Development of Bilinear Quadratic Structure For Effective Active Queue Network Management

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Abstract

Active Queue Management (AQM) on TCP/IP network manages packet transfer and keeps away from congestion. FavorQueue (FQ) mechanism provided efficient way for packet retransmission when the network was congested and also favored short TCP traffic with an ordered linked list as a function for varying flow length of packets. Though FavorQueue minimized the packet drop ratio and latency, rate-based transport congestion control was not provided on active queue management. Random Early Detection (RED) algorithm constructed the model traffic flow volume using TCP protocol. But the occurrence of congestion was high using RED algorithm and also the packet loss measured was high. To attain a complete active queue analysis, Active Queue Management based on the Bilinear Quadratic Structure (AQM-BQS) mechanism is proposed in this paper. In AQM-BQS mechanism two phases are combined together to forward the packets without any loss of information on the receiver side. In the initial phase, bilinear structure is developed using rate-based transport congestion control protocols to analyze the time-dependency. Bilinear structure also concentrates on reducing the percentage of packet loss while transferring through multiple route paths. A rate-based transport congestion control protocol uses probabilistic distribution on bilinear structure by tuning the arrival rate of the incoming packets and thereby reducing the packet loss. In the second phase of the proposed work, Standard Quadratic feedback system is developed to improve the throughput level in the AQM-BQS mechanism. The Standard Quadratic feedback system in AQM-BQS mechanism uses the bilinear structure information to measure the throughput level of the packets which are transferred through bilinear routes. AQM-BQS mechanism performs the experimental factors such as throughput level, congestion control rate, and time taken for packet transfer.

Keywords:- Active Queue Management, Bilinear Quadratic Structure, TCP/IP network, Rate-based Transport Congestion Control, Probabilistic Distribution, Standard Quadratic feedback

1. Introduction

One of the serious problems over the past decades in internet is congestion control. Without significant amount of management of congestion, the performances of internet gets highly affected and to name some others are, minimized utilization of link, increased time on round-trip and finally there is also a possibility to make the entire network inaccessible. But, at the same time, many approaches and technique have been suggested by many eminent scholars to provide an efficient solution to this issue.

FavorQueue [1] provided with an analysis and implementing a new type of active queue management (AQM) that resulted in improving the delay transfer of short lived TCP flows with the basis assumption that dequeued packets that did not belonged to the flow of packets that were enqueued first. Though FavorQueue reduced the packet drop ratio and latency, rate-based transport congestion control was not addressed on active queue management.

The main objective of Active Queue Management (AQM) is stabilizing the length of the queue to provide an optimal amount of tradeoff between two parameters, throughput and delay. In [2], detailed analysis was made with different queue management policies using Random Early Detection (RED) algorithm that constructed the model traffic flow volume using TCP protocol. But the occurrence of congestion was high using RED algorithm and also the packet loss measured was high. NetBump [14] provided a platform for measuring and evaluating strategies related to active queue management with minimal intrusiveness rate and low latency level. But the performance at which the latency was provided was less.

One of the active research topics in Internet is the rate at which the traffic is stable with increased number of users observed in the network. It has been proved that, without delay observed during feedback and with the application of Additive Increase and Multiplicative Decrease (AIMD) congestion control mechanism, integrated with Random Early Detection algorithm, stability can be ensured.

The practical level of stability of AIMD/RED [6] was studied for both the homogeneous and heterogeneous types of flow in Internet by obtaining the bound levels of window size and queue length that resulted in increased level of throughput. But short-lived flows remain unaddressed. Based on the limitations, an improved algorithm called as an improved adaptive RED congestion control mechanism [9] was designed which utilized a principle of nonlinear smooth for packet loss by applying the membership function to improve throughput and minimize packet loss rate. But average queue length was not considered and remained an open issue.

Delay-based Additive Increase Multiplicative Decreased (AIMD) [13] was designed with the main aim of delay based flow for homogeneous environments, tradeoff between delay and loss based flows on heterogeneous environments in order to achieve low delay. But one of the main drawback observed here is that every flows use the same backoff probability function and same delay during queue which was the main drawback. Simulation analysis of different Active Queue Management was designed in [14] that included Random Exponential Marking (REM), Gentle RED and Nonlinear RED (NLRED) to provide better throughput and minimize average queue length. But the major factors like bandwidth utilization, latency were not considered. Purge (Pricing and Un-Responsive flows purging for Global rate Enhancement) [19] extended the framework of REM to regulate unresponsive flows by minimizing the bandwidth utilization using MINCOUNT algorithm.

With the existent reliable transport-layer protocol, Transport Control Protocol (TCP) is extensively applied on the Internet. But research conducted on recent studies however showed that TCP is not highly suitable for traffic patterns that follow a many-to-one procedure with higher amount of bandwidth and with lower latency. ICTCP [5], Incast Congestion control for TCP was designed in detail with the main concentric on building the relationships between the throughput level observed over TCP, time observed for round-trip (RTT), and receive window. With the core mechanism of classification of packets, handles different types of networking services on the Internet. In [10], an approach, Ternary Content Addressable Memories (TCAM) was presented to reduce the TCAM rules for effective rule classification.

In this paper, we present an effective active queue network management using bilinear quadratic structure on TCP/IP network. As higher throughput level with lower congestion control is highly desirable to forward the packets without any loss of information on the receiver size, the work AQM-BQS mechanism consider both the measures by applying a rate-based transport congestion control protocol. We have also carefully designed the model for reducing the packet loss by applying Standard Quadratic feedback system. We make the following contributions:

A mechanism of Active Queue Management based on the Bilinear Quadratic Structure (AQM-BQS) with different number of nodes is presented.

Design of rate-based transport congestion control to reduce the packet loss using probability distribution function is considered.

The Standard Quadratic feedback system to improve the throughput level using bilinear structure information is designed.

A Rate-based transport congestion control Algorithm to improve the queue management on TCP/IP network is developed.

Simulation study to measure the efficiency of the AQM-BQS mechanism is performed.

The outline of the paper is as follows. In Section II, the active queue management based on bilinear quadratic structure mechanism is explained with an overview of architecture. In Section III, the experimental section with detailed analysis of the result is presented with detailed analysis of the result is provided in Section IV. In Section V, an elaborate review on the recent advances in active queue management with an emphasis of throughput and congestion rate is provided. Finally, Section VI provides with concluding area.

2. Active Queue Management Based On Bilinear Quadratic Structure Mechanism

In this section we present an efficient active queue management mechanism based on bilinear quadratic structure for the effective packet transfer on TCP/IP network. The intuition behind the proposed mechanism is that the bilinear quadratic structure development uses the rate-based transport congestion control to reduce the processing time. The bilinear structure in TCP/IP network includes two layers namely input data path and the output data path. With this, the bilinear connection within the route path helps to easily identify the packet loss in AQM-BQS mechanism. The purpose of bilinear structure is to demonstrate an active queue network management on the basis of spontaneous activity in the input data path. The data packet is transmitted from the input data path to the multiple output paths using rate-based transport congestion control to reduce the packet loss with time dependency level.

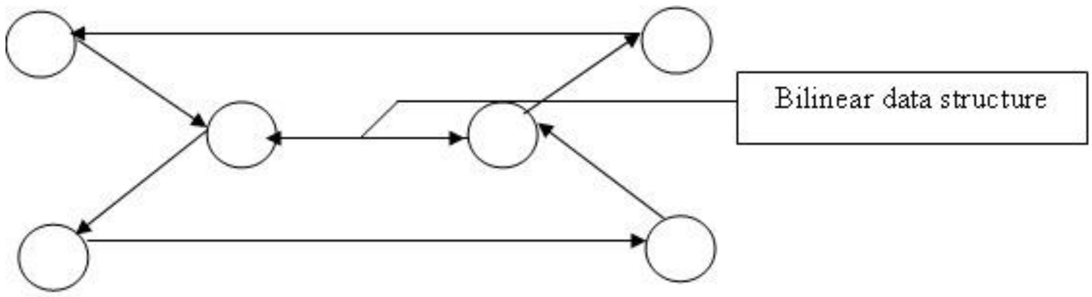

Figure 1: Data Packet Transfer through Bilinear Path

As illustrated in Figure 1, Bilinear path is selected for packet transfer over multiple links (i.e., to and fro packet transfer through the path). With the adaptation of rate-based congestion control, bilinear path over multiple links are provided with lesser congestion rate attained using the probabilistic distribution function. The probabilistic distribution function in AQM-BQS mechanism assigns a probability to each multiple links path and measures the possible outcomes. The detailed architecture diagram of Active Queue Management based on Bilinear Quadratic Structure (AQM-BQS) mechanism is described in Figure 2.

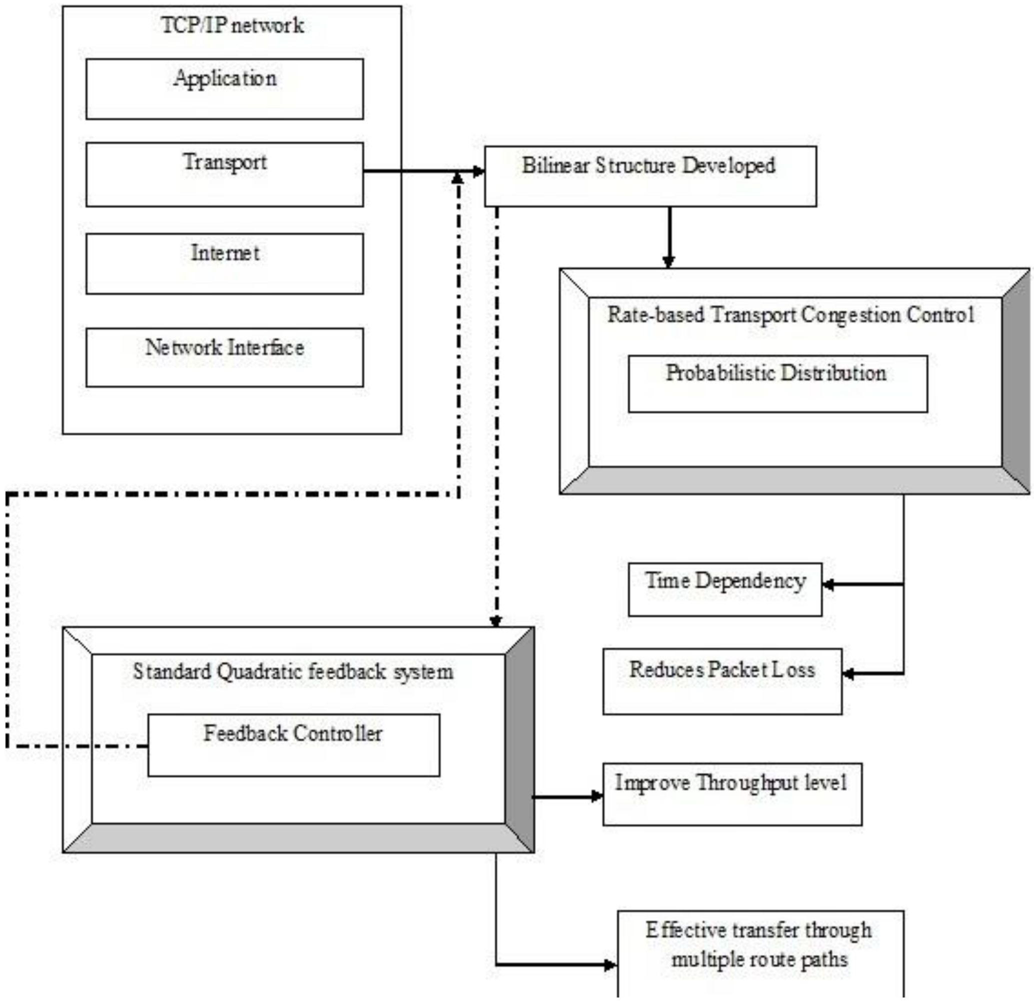

Figure 2: Architecture Diagram of AQM-BQS Mechanism

As illustrated in Figure 2, AQM-BQS mechanism performs the operations on TCP/IP network. The TCP/IP network offer effective connectivity provided with addresses, transmitted path rate, and multiple route paths discovered from source to destination. The TCP/IP holds the network interface at the bottom of the layer to link the route path. The internet layer in the TCP/IP establishes the connectivity between different network structures. The transport layer helps in transferring the packet data to the destination path by handling the congestion. The application layer in AQM-BQS mechanism provides process-to-process data exchange in TCP/IP.

The transferring of data packet is performed through bilinear structure. Rate-based Transport Congestion Control uses probabilistic distribution function to reduce the packet loss and processing time in active network management. Secondly, the standard quadratic feedback system is developed with feedback controller to improve the throughput level while transferring the packet through the multiple route paths.

Design of Bilinear Structure Rate-based Transport Congestion Control

Rate-based Transport Congestion control in AQM-BQS mechanism consists of a vector space ‘V’ over the routing path ‘P’. The quadratic form is a function used in the bilinear structure to improve the feedback result on the TCP/IP network. Let us consider the nodes ‘u’, ‘v’ and ‘w’ in TCP/IP network to transfer packet through multiple paths. The structure is described as,

$$p(u, v, w) = [(u, v + w), (u + v, w), (u + w, v)]$$

Eqn (1)

Using the bilinear structure in Eqn (1), the packets are passed through multiple route paths, so that packet loss is clearly noticed and congestion can be controlled. The vectors carry different node route paths to transfer the data packets. The rate-based transport congestion control is maintained through the time dependency factor, where

$$Time\ factor\ (T) = \ Rate\ (r) + \alpha \qquad \ldots$$

Eqn (2)

‘α’ denotes the added time factor while performing the round trip time. The round trip time evaluates the occurrences of multiple link congestion. The packet loss in the rate-based transport congestion control is also obtained by evaluating

$$Packet\ Loss = r + \beta$$

Eqn (3)

Eqn (3) clearly detects the packet loss using the β factor. With the help of probabilistic distribution, the ‘β’ counts of packet loss is reduced in AQM-BQS mechanism. The probabilistic distribution $Prob\ Distribution\ (t)$ on multiple links on period t is described as,

$$Prob\ Distribution\ (t) = 1 - \varphi^{-ML\,(t)}$$

Eqn (4)

In Eqn (4), φ is a constant larger than 1. The parameter φ determines the range of loss probability, which depends on the multiple link paths (ML). The value of φ is chosen in such a way that the end-to-end probability is observed in AQM-BQS mechanism. The AQM-BQS mechanism uses the probability distribution function to reduce the packet loss and as a result time dependency is also maintained. The rate-based transport congestion control in AQM-BQS mechanism is described as,

// Rate-based transport congestion control Algorithm
Begin
Input: Multiple path ‘P’, ‘u’, ‘v’ and ‘w’ nodes, Vector Space ‘V’
Output: Congestion Control on Active Queue network Management ‘M”
Step 1: Rate adaptation scheme is prescribed for multiple links
Step 2: Bilinear structure developed on transferring ‘P’ through multiple paths ‘p’

Step 3: Rate Congestions Control through time dependency factor
Step 3.1: $Time\ factor\ (T) = \ Rate\ (r) + \alpha$ computed for round trip time
Step 4: Rate Congestions Control by reducing packet loss
Step 4.1: $Packet\ Loss = r + \beta$ computed
Step 5: Employed Probabilistic Distribution Function
Step 5.1: Computed $Prob\ Distribution\ (t) = 1 - \emptyset^{-ML\ (t)}$ over the multiple link paths 'ML'
Step 6: End to end packet transfer probability is observed
End

The above algorithmic steps describe the AQM-BQS mechanism. Bilinear structure helps in improving the queue management on TCP/IP network. The time dependent factor helps in rate-based transport congestion control, thereby reducing the packet loss rate. As a result, Rate-based transport congestion control increases the strength of active queue network system and utilization rate by combining the bilinear structure and quadratic form.

2.1 Standard Quadratic Feedback system

he feedback controller in AQM-BQS mechanism sends the feedback message to the bilinear structure to conform the message. The message conforms that the packet transfer is performed effectively in active queue management system using the rate-based transport congestion control. With this, the throughput level gets raised on packet transfer through the transport layer of the TCP/IP framework.

The TCP/IP network carries the node in a bilinear form. The bilinear structure uses the rate-based transport congestion control for reducing the packet loss in the AQM-BQS mechanism. The bilinear structure used in the quadratic feedback system minimize the undesired deviations, thereby reduces the packet loss over multiple path. The TCP network packet transfer through quadratic feedback system is described as,

$$Quadratic\ Function\ (P_{tcp}) = \frac{\frac{ML}{T}}{r + \frac{T}{(\mathrm{MC})^2}}$$

Eqn (5)

Eqn (5) clearly describes the packet transfer through the TCP/IP network $P_{tcp}$where the rate r is controlled using a specified time factor T . The specified time factor varies on packet transfer through multiple paths.

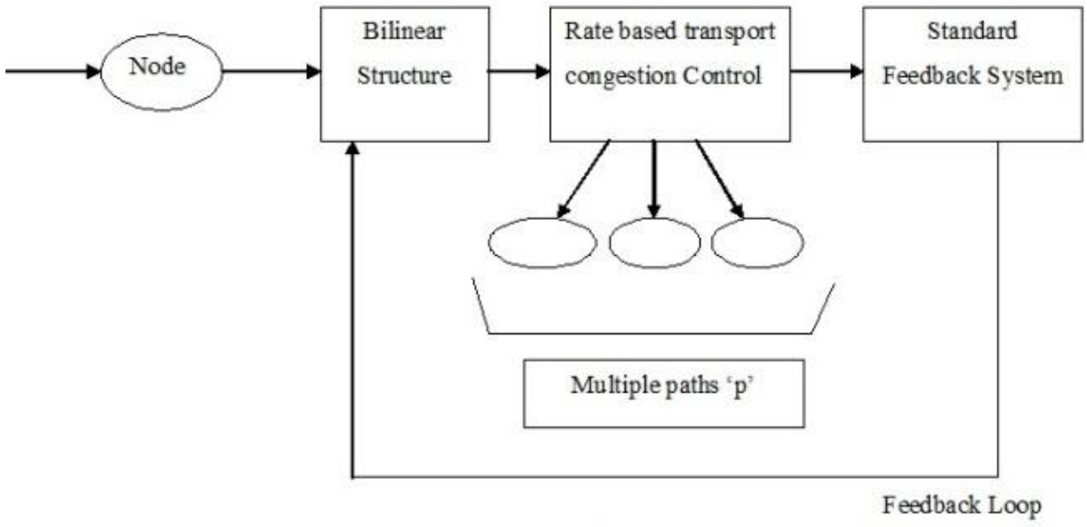

Figure 3: Quadratic Feedback System

The diagrammatical representation of quadratic feedback system for AQM-BQS is depicted in Figure 3. The total number of packet transmitted 'P' over the multiple paths p is described as,

$$P(t) = \int_{o}^{t} r(\tau) d\tau$$

Eqn (6)

$P(t)$is the packet transferred and throughput level is integrated from '0' to time 't'. The transmitted packets send the feedback information to bilinear structure to analyze the throughput level. In AQM-BQS mechanism, the steady state throughput is computed as,

$$Throughput\ rate = Quad(P_{tcp}) + Quad(r)$$

Eqn (7)

The throughput rate is clearly described as the quadratic function of packet 'P' and the rate of packet flow through quadratic function. The packet transfer through TCP helps to identify the throughput through quadratic function.

3. Experimental Evaluation

Active Queue management based on Bilinear Quadratic Structure (AQM-BQS) mechanism is experimented in the TCP/IP network using the ns-2 simulator. The TCP-IP network is chosen of size 1000 ×1000. The network is taken to experiment the handoff process while discovering the service on mobile nodes. AQM-BQS mechanism holds 100 to 800 (m/s) simulation results. The random progression is constant during the simulation period of the TCP/IP network. The minimum moving speed of the sensor node is about 3.0 m/s of each node.

Random Waypoint model is developed to randomly choose and moves another node location point by forwarding the packets to multiple neighboring nodes. RWM model shifts to a randomly chosen location. RWM uses average of about 75 numbers of nodes for route discovery. The chosen location with an arbitrarily chosen speed contains a predefined quantity and speed count. Dynamic Source Routing (DSR) Protocol is used in AQM-BQS mechanism for effective route discovery. The arbitrarily selected location with a chosen velocity provides a predefined speed.

The experimental work is compared against the existing FavorQueue (FQ) [1] mechanism and Random Early Detection (RED) algorithm [2] to identify the effectiveness of AQM-BQS mechanism. The experiment is conducted on the factors such as throughput level, packet loss rate, congestion control rate, time taken for packet transfer.

In table 1 we evaluate the performance of throughput level using the AQM-BQS mechanism. The number of nodes used in this experiment ranges from 10 to 70 nodes. The performance of throughput level is measured in terms of bits per second or bps that defines the ability to test the throughput level of the packets which are transferred through bilinear routes depending on the nodes in the network. The test result with the high throughput level with successful delivery of packets. The values of throughput level are obtained from eqn (7).

In order to minimize the packet loss rate, bilinear structure is used that reduces the percentage of packet loss based on rate-based transport congestion control protocol. In the experimental setup, the queue size ranges from 5 to 35. The results of 7 different queue sizes placed by the nodes are listed in table 2. As listed in table 2, AQM-BQS mechanism measures the amount of packet loss rate which is measured in terms of bits per second (bps). The packet loss rate consumed using AQM-BQS mechanism offer comparable loss rate than the state-of-the-art methods. The packet loss rate PLR is the difference between the packets transmitted PT and packets received PR measured using the following equation

$$PLR = PT - PR$$

In table 3 we further compare the Congestion Control Rate of coarser construction of the proposed method using the Rate-based transport congestion control Algorithm. The experiments were conducted using the nodes in the range of 10 to 70 that measures the congestion control rate efficiency which is measured in terms of bits per second (bps).

Finally, table 4 provides the time taken for packet transfer with varying queue sizes of range 5 to 35 that measures the amount of time consumed to perform the packet transfer. The time taken for packet transfer PTT is evaluated using the ratio of packet size PS and the bite rate BR with the packet transfer rate time measured in terms of milliseconds (ms).

$$PTT = \frac{PS}{BR}$$

4. Result Analysis

To better understand the effectiveness of the proposed AQM-BQS mechanism, extensive experimental results are reported in table 1. The proposed AQM-BQS mechanism is compared against the existing FavorQueue (FQ) [1] mechanism and Random Early Detection (RED) algorithm [2]. NS2 simulator is used to experiment the factors and analyze the result percentage with the help of table and graph values. Results are presented for different number of nodes considering the throughput level. The results reported here confirm that with the increase in the number of nodes, the throughput level is also increased. Finally, the value of throughput level that is measured in bits per second gets saturated when the number of nodes ranges from 60-70.

Table 1 Tabulation for Throughput Level

Nodes (N)	Throughput Level (bps)		
	AQM-BQS mechanism	Favor Queue (FQ)	Random Early Detection (RED)
10	1.35	1.22	1.18
20	1.48	1.33	1.28
30	1.55	1.38	1.25
40	1.42	1.31	1.22
50	1.63	1.58	1.32
60	1.68	1.60	1.44
70	1.72	1.64	1.48

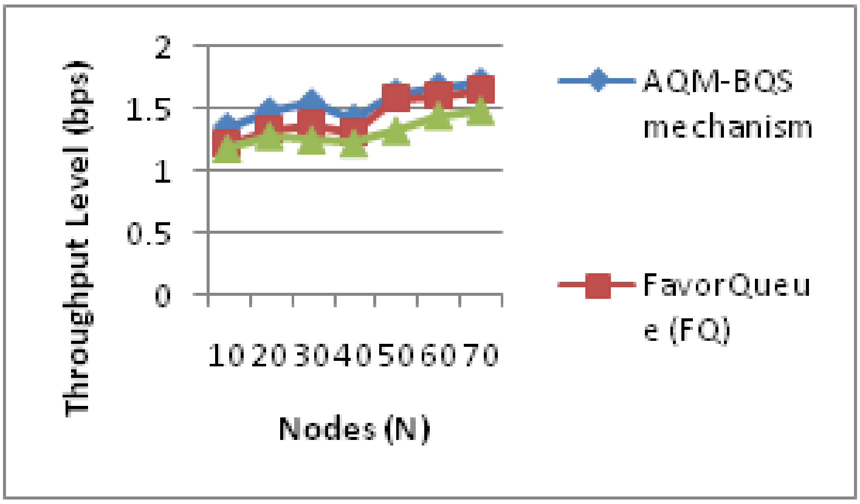

Figure 4: Measure of throughput level

Figure 4 illustrate the throughput level based on the nodes. Our proposed AQM-BQS mechanism performs relatively well when compared to two other methods FavorQueue [1] and Random Early Detection [2]. The algorithm had better changes where the nodes in the TCP/IP network changes rapidly that helps to easily cover the entire route path with improved throughput level using the Standard Quadratic feedback system. AQM-BQS mechanism easily covers the entire route path with improved throughput level by 3 – 10 % when compared with the FavorQueue mechanism [1]. The Standard Quadratic feedback system with feedback controller uses the bilinear structure information to measure the throughput level of the packets which are transferred through bilinear routes and improves the throughput level by 12 – 19% when compared with the Random Early Detection [2] algorithm.

Table 2: Tabulation for Packet Loss Rate

Queue Size	Packet Loss Rate (bps)		
	AQM-BQS mechanism	Favor Queue (FQ)	Random Early Detection (RED)
5	2.35	2.48	2.52
10	2.38	2.45	2.55
15	2.45	2.50	2.58
20	2.41	2.55	2.56
25	2.50	2.58	2.60
30	2.52	2.65	2.70
35	2.55	2.68	2.78

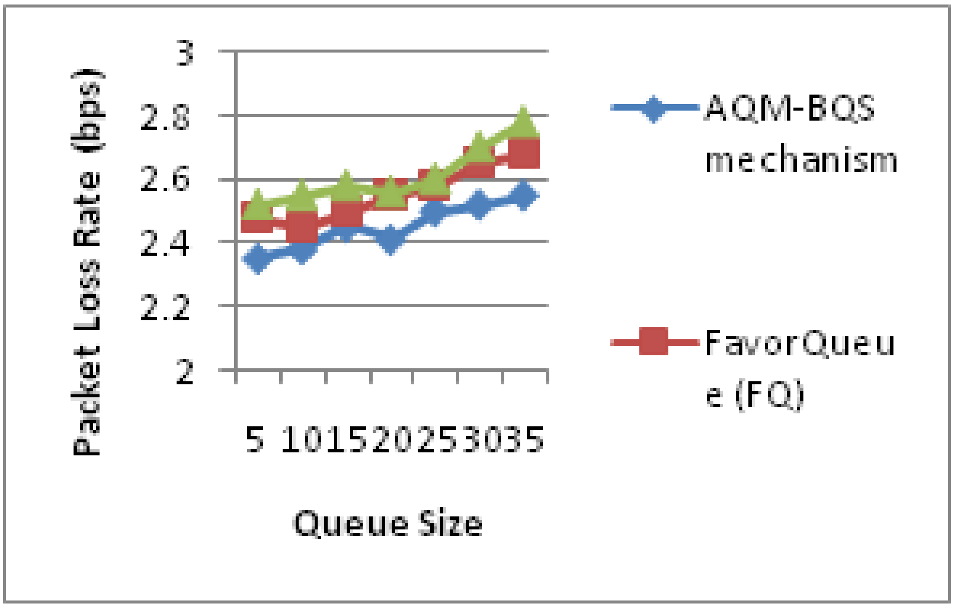

Figure 5: Measure of Packet loss rate

The targeting results of packet loss rate using AQM-BQS mechanism with two state-of-the-art methods [1], [2] in figure 5 is presented for visual comparison based on the varied queue sizes. Our mechanism differs from the FavorQueue mechanism [1] and Random Early Detection [2] algorithm in that we have incorporated a rate-based transport congestion control protocol to easily extent the queue sizes and by tuning the arrival rate of the incoming packets reduces the packet loss. For the most different number of queue sizes, AQM-BQS mechanism achieves comparable performance to FavorQueue and Random Early Detection. The packet loss rate is 2 – 5 % better when compared with the FavorQueue mechanism [1]. With this, the bilinear connection within the route path helps to easily identify the packet loss in AQM-BQS mechanism and reduces it by applying Bilinear structure while transferring through multiple route paths for varying queue sizes with 4 – 9 % lesser packet loss rate when compared with the Random Early Detection [2] algorithm.

Table 3:Tabulation for Congestion Control Rate

Nodes (N)	Congestion Control Rate (bps)		
	AQM-BQS mechanism	FavorQueue (FQ)	Random Early Detection (RED)
10	0.75	0.65	0.62
20	0.79	0.71	0.68
30	0.82	0.79	0.72
40	0.74	0.64	0.62
50	0.83	0.75	0.71
60	0.85	0.78	0.75
70	0.91	0.85	0.82

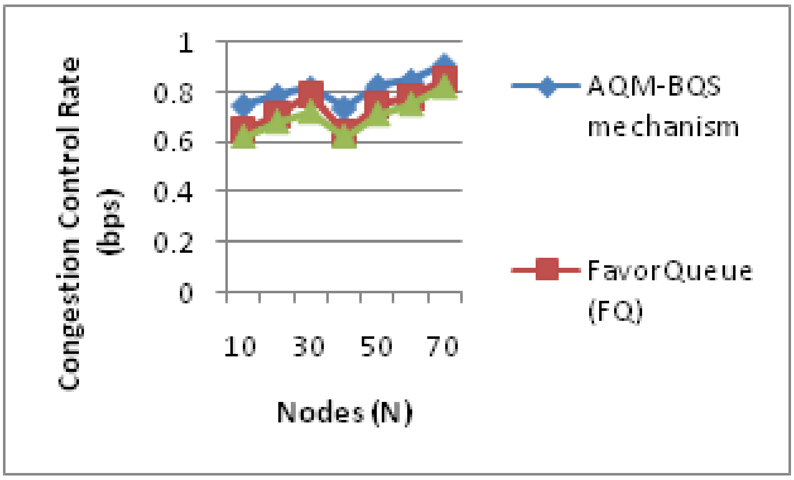

Figure 6: Measure of Congestion control rate

To explore the influence of congestion control rate on AQM-BQS mechanism, the experiments were performed by varying the number of nodes as depicted n figure 6. It also shows that the AQM-BQS mechanism shows competitive results with the state-of-the-art methods, namely FavorQueue mechanism [1] and Random Early Detection [2]. Even though the AQM-BQS mechanism uses bilinear path over multiple links, low congestion control rate was recorded especially at nodes 30 and 70. This is because the AQM-BQS mechanism manages the congestion control rate using rate-based congestion control. The congestion control rate is reduced by 3 – 13 % when compared with the FavorQueue mechanism [1]. Probability distribution function is used to minimize the rate of congestion by measuring the weighting factors, queue arrival rate and queue service rate that in turn decreases the congestion control rate on the TCP/IP network by 7 – 17 % when compared with the RED.

Table 4: Tabulation for Time taken for Packet Transfer

Queue Size	Time taken for Packet Transfer (ms)		
	AQM-BQS mechanism	FavorQueue (FQ)	Random Early Detection (RED)
5	25	32	35
10	28	33	38
15	32	37	41
20	30	31	42
25	35	38	44
30	38	43	47
35	41	45	52

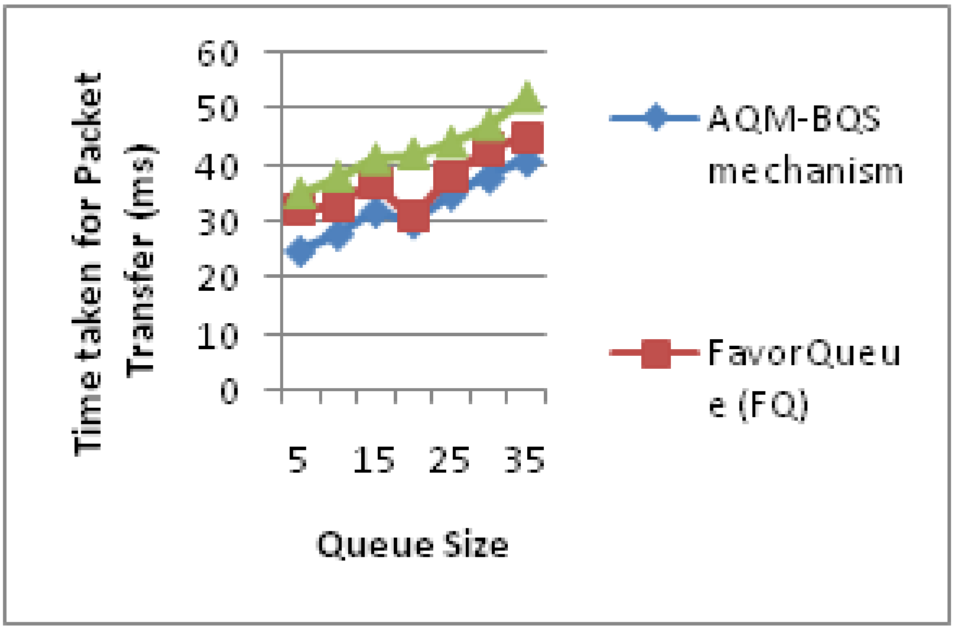

Figure 7: Measure of Time taken for packet transfer

Lastly the time taken for packet transfer is measured via a queue size of 5 to 35. From the figure 7 it is illustrative that the proposed AQM-BQS mechanism potentially yields better results than existing FavorQueue mechanism [1] and Random Early Detection algorithm [2]. The significant results achieved using AQM-BQS mechanism is because the bilinear quadratic structure development uses rate-based transport congestion control in active network management on TCP/IP network. As a result, the time taken for packet transfer is reduced to a coarser construction. The time taken for packet transfer is reduced up to 6 – 13 % when compared with the FavorQueue mechanism [1], and 9 – 17 % reduced when compared with the RED [2].

5. Related Works

In the current Internet scenario, the most used transport protocol is TCP, which, in the lack of feedback from the gateway nodes results in congestion, affecting the packets or throughput changes or end-to-end delay. However, the impact of TCP congestion control mechanisms does not affect the instability level in queue length and higher amount of variations in delay. Due to this, several active queue management (AQM) technique, have been structured in the last few years to provide solutions to performance degradation.

Active Window Management (AWM) [3] not only enhanced the TCP congestion control but also stabilized the queue length over a threshold value with smaller number of oscillations. In AWM only some of the system parameters were evaluated whereas the congestion rate was unaddressed. As a queue management policy, NewReno [4] introduced an accurate stochastic model for the optimal level of throughput in TCP/IP network. A function of round-trip time and congestion loss behavior was analyzed by characterization of analytical values with a time-out two-parameter loss model to maximize the level of throughput and reduce the congestion to a significant level.

Adaptive AQM (AAQM) [20] investigated robustness with burst traffic and introduced Markov Modulation Poisson Process (MPP) to provide with higher throughput in the presence of burst traffic. An Adaptive Random Early Detection [17] algorithm was designed that dynamically changed the packet drop rate according to the network size using exponential average weight system to stabilize the queue length and increase the stability.

Congestion in Internet arises whenever the demand for a resource is greater than the available resource. In a similar manner, congestion, due to the discrepancy is speed between wired and wireless LAN (WLAN) network is considered to be the most critical issues that severely degrades the overall performance of WLAN. NPD-RED [7], a self-tuning feedback and differential controller, which not only considers the instant length of the queue, but also considered ratio of current error signal to buffer size to improve the throughput and stability. Though issues related to single bottleneck was addressed channels related to multiple bottlenecks remained an open issue.

A Variable Congestion control Protocol [15] was designed that not only provided fairness but also differentiated between congestion and error causes with fading and included measures for multiple bottlenecks. But, link bandwidth estimation errors were unaddressed. In certain types of many networks, it seems to be relatively less costly to perform packet transmission to a single node rather than with a group of neighbor nodes. Least Cost Anypath Rouging (LCAR) [11] was designed that efficiently allocated group of candidate relays at each node for a given destination so that the cost for packet forwarding was reduced. Though cost was considered, time taken to perform packet forwarding was unaddressed. Healthcare aware Optimized Congestion Avoidance and control protocol [16] was designed specifically for applications related to healthcare to provide solutions with end to end delay, consumption level of energy and fairness.

With the increased growth of applications related to multimedia like video streaming, video conferencing and so on, the traffic has increased drastically and better Quality of Service have to be provided for end-to-end communication between the users. These can be provided by efficient mechanisms for packet scheduling and classification, monitoring of traffic at regular intervals, optimal utilization of bandwidth, and resource reserving. In [8], the problems related to AQM in multimedia streams were addressed in an efficient manner based on a NP-based active router by minimizing the packet queuing delay. Some of the open issues in the NP space include software durability, which they share with many other specialized, embedded systems.

Traffic Sensitive Active Queue Management (TSAQM) [18] provided multimedia services in routers by using Dynamic Weight Allocate Scheme (DWAS) and Service Guarantee Scheme (SGS) and provided better throughput and minimized packet drop rate. Though high throughput was ensured, time complexity increased proportionately.

6. CONCLUSION

In this work, we address the problem of complete active queue analysis in TCP/IP network and propose an Active Queue Management based on the Bilinear Quadratic Structure mechanism to achieve maximum throughput level and minimize the congestion control rate. We show how different queue sizes can be used in a ubiquitous fashion to drastically reduce the time taken during packet transfer and packet loss rate in the TCP/IP network. We study how this reduction in packet loss rate translates into congestion control rate and obtain optimal throughput level on TCP/IP network. We further show attainable performance gains of the proposed strategy in terms of throughput level that can achieve well above 20 percent compared with the state-of-the-art methods on TCP/IP network. Moreover, with the application of Rate-based transport congestion control algorithms further increases the strength of the active queue network system, that utilize the rate congestion control and probability distribution function that results in marginal improvements in increasing the throughput level for many nodes. We have also considered how congestion control rate could prove beneficial in attaining near optimal solutions for throughput level while maintaining the time taken for packet transfer for different nodes with varying queue sizes. Finally by using the quadratic function, further improvements in throughput is attained.

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