Path Stability based Enhancement Mechanism for QoS Provisioning in Optical Burst Switching Networks

P. Boobalan1, N. Sreenath2,

1Assistant Professor, Department of Information Technology
Pondicherry Engineering College, Pondicherry – 605 014, India
2Professor, Department of Computer Science and Engineering,
Pondicherry Engineering College, Pondicherry – 605 014, India
1boobalanp@pec.edu
2nsreenath@pec.edu

Abstract— Quality of service (QoS) provisioning is considered to be one of the characteristic features in Optical Burst Switching Networks. Furthur, Survivabiltiy of optical networks is more challenging since single point failure may lead to huge data loss that could occur due to the large capacity of optical fibers.Hence, there arises a need for formulating an effective and efficient QoS provisioning mechanism in Optical Burst Switching Networks. In this paper, we formulate a Path Stability based Enhancement Mechanism for QoS Provisioning (PSEMQoS) which handles both synchronous and asynchronous path based QoS provisioning. The proposed PSEMQoS mechanism is highly adaptive to variations in traffic patterns by incorporating dynamic exchange of wavelengths and time slots for resolving bursty switch over problem. The proposed PSEMQoS also incorporates a Link stability based Opportunistic routing algorithm for estimating a reliable path between the source and destination in a hop by hop manner for handling bursty traffic. The performance of PSEMQoS is exhaustively studied through ns-2 simulations with the aid of evaluation parameters such as Jitter, Packet delivery ratio, Burst loss ratio and average goodput. From the simulation results obtained, it is transparent that PSEMQoS successfully reduces the burst loss probability when compared to the other path based QoS provisioning mechanisms available in the literature.

Keywords: Quality of Service, Path Based QoS, Opportunistic routing, Just-in-Time, Optical Burst Switching, link stability, adaptive traffic pattern.

1. INTRODUCTION

OPTICAL burst switching (OBS) is a switching technology that was proposed as a candidate transport solution for next-generation optical Internet [1]. OBS is considered as a trade off between optical circuit switching (OCS) and optical packet switching. Hence, the OBS paradigm is a candidate to play an important role in next-generation networks framework for which quality- of-service (QoS) provisioning is considered as an essential feature. In this paper, we analyze the traffic pattern and overcome the constraint problem in terms of link failure in order to provide the proper QoS to satisfy the receiver in the network[2] .More specifically, we propose efficient opportunistic algorithm to tackle both synchronous (overlapping path) PQP (Path Based QoS Provisioning) and asynchronous (non overlapping path) PQP adaptive to traffic pattern variations by allowing paths to exchange wavelengths and time slots and also we overcome the bursty switchover problem.

A video on demand provider using an OBS transport network is needed to deliver traffic to a set of egress destinations. A large part of this traffic would be composed of video streaming traffic. However, in a real network there would be also a fraction of non video traffic related to non video services. This work studies the decision whether it is better to gather all traffic to the same destination in a joint burst assembler or separate video and general data traffic on different burst assemblers. The later may increase burst blocking probability but also allow for better tuning of OBS parameters that help improve video reception quality. In this paper, the major contributions are:

1) Adaptive traffic pattern analysis for the OBS network which improves the traffic pattern under the video transmission.
2) Implementation of opportunistic routing algorithm that chooses the best routing path when the there is a loss in transmitting the video signal
3) Restriction of the illegal uses of services from the server by recording the user information details in content server.

Rest of the paper is organized as follows. A Comprehensive level of Literature review is presented in Section 2. The network design used for formulate a Path Stability based Enhancement Mechanism for QoS

Provisioning (PSEMQoS) is discussed in Section 3.A fast restoration mechanism based on opportunistic routing through deflection routing is discussed in Section 4. Results from a comprehensive simulation study and the discussion of its results are presented in Section 5. Section 6 concludes the paper.

2. RELATED WORK

From the past decade, intensive level of research has been carried out for the formulation of Path Stability based QoS Provisioning mechanism which handles both synchronous and asynchronous path based QoS provisioning. The mechanism available in the literature are classified into i) Path based QoS provisioning, ii) Tell –And -Go provisioning ,iii) Just –in –Time and iv) Just Enough Time.

i) Path based QoS provisioning:

Path based QoS provisioning clearly distinguishes the QoS provision based on i) the number of wavelengths available at an instant, the number of feasible paths enabled between the source and the destination with the routing paths configuration allows to establish non overlapping paths between each pair of edge nodes (*asynchronous PQP)* and ii) the limited number of wavelengths makes some paths overlap (i.e., use the same wavelength on at least one link); we call this case *synchronous PQP*; we explain how PQP provides QoS provisioning in each case .In this paper we are discussed the PQP concept in terms of application of traffic pattern .We are transmitting the video or audio signal in the network.

ii) Tell –And -Go provisioning:

In this scheme, the control packet is transmitted over a control channel appended by a payload .The payload is always buffered using fiber delay line (FDL) while the control packet is processing at each intermediate node. If wavelength reservation is successful then the payload is transmitted along the reserved channel else the data burst is dropped and a negative acknowledgment (NAK) is sent to the source. The source node sends a control packet after transmitting the payload to release the reserved resources along the path. The drawback of this scheme is availability of optical buffer. FDL can hold data only for a fixed duration and can not accommodate data burst of variable size. Furthermore, loss of control packet to release reserved resources result in wastage of bandwidth

iii) Just –in –Time provisioning

JIT is a reservation scheme. Here, nodes reserve the resources as soon as the control packet is processed. Source transmits the payload after an offset time which is greater than the total processing time of control packet at intermediate nodes. If the resource is not available, the data burst is dropped. The difference between JIT and TAG is that in JIT the buffering of the payload at each node is eliminated by inserting a time slot between the control packet and the payload. The time slot is equal to the offset time. Since the bandwidth is reserved immediately after processing the control packet, the wavelength will be idle from the time the reservation is made till the first bit of the payload arrives at the node. This is because of the offset between the control packet and the payload. An in-band- terminator is placed at the end of each data burst, which is used by each node to release the reserved wavelength after transmitting the payload .

iv) Just-Enough-Time Provisioning.

JET is a delayed reservation scheme. Here, the size of the data burst is decided before the control packet is transmitted by the source. The offset between control packet and payload is also calculated based on the hop count between the source and destination. At each node, if bandwidth is available, the control packet reserves wavelength for the upcoming data burst for a fixed duration of time. The reservation is made from the time when the first bit of payload reaches the node till the last bit of payload is transmitted to the output port. This eliminates the wavelength idle time. This is the basic difference between JET and JIT. Since the wavelength is reserved for a fixed duration, there is no need for explicit release of reserved resources along the path. Since there is no wastage of bandwidth in this scheme, channel utilization is higher than other schemes. TAG and JIT schemes are significantly simpler than JET since they do not involve complex scheduling or void filling algorithms. Previous studies have shown that JET performs better than either JIT or TAG in terms of burst loss probability.

Extract of the Literature.

The literature review carried out with the existing works available for QoS provisioning in optical burst networks has the following shortcomings they are:

- A mechanism is highly adaptive to variations in traffic patterns by incorporating dynamic exchange of wavelengths and time slots for resolving bursty switch over problem has not been much explored to the best of my knowledge.
- A Mechanism which could deal with the issues and impacts of synchronous and asynchronous path based QoS provisioning is not available in the literature.

These are the factors that motivated for devising a link stability based QoS provisioning in optical burst networks that helps in enhancing the process of reliable transmission of data .

2. NETWORK DESIGN ANALYSIS FOR PROPOSED WORK

The architecture of Optical busrt-swithced network used for our proposed system contains two types of nodes viz., edge node and core node. Edge nodes are present in the interface point between the optical and electronic domain. The packets are always assembled into bursts at the ingress node and are disassembled at the egress node. The core node mainly comprises of optical switching matrix and switch control unit for forwarding burst of data.Furthur,a network management system is designed to design, organize, analyze and administer the optical networks in order to maintain a desired level ofservice at all specific times. We consider both content Server and management server. We connects the content server with management server and then management server is connects to routers. We consider the initial routers with same distance from the management server. Then we connect each router to multiple numbers of users.

Content server

Content Server regularly updates the information about the routing to ensure that the correct messages are being disseminated so that a scheduling system can be incorporated using a data feed from a content provider or an in-house data source.

Management Servers

A management server is usually required to record the user requests and services provided by the server is maintained in the content server..In the management server we maintain the record set of which user use the service (video signal) at a particular time. We record the user details in this server in order to prevent the illegal use of services from the server without the server knowledge. In order to maintain the record set of services we introduce three parameters, they are f-measure, precision, recall .These are the evaluation measures which are typically used for (Internet) Information Retrieval about total number of users

3. PROPOSED SOLUTION

3.1 Overview

In this paper, we implement a burst switching mechanism which incorporates opportunistic routing algorithm based on the concept of multipath routing when there is a link failure between the management server and the router during the transmission of video signal .This mechanism also emphasis Optical Burst Switching as a photonic network technology for enabling efficient transport of IP traffic.Furthur,this mechanism proves that the OBS architectures without buffering capabilities are highly sensitive to burst congestion. Furthurmore,This mechanism also reduces burst loss probability which adequately represents the congestion state of entire network..

3.2 Path Stability based Opportunistic Routing Algorithm (PSORA) for QoS enhancement in OBS.

This paper proposes an opportunistic routing algorithm in which the routes are computed at each hop when the packets are forwarded from the source to the destination. Hence, each and every node receiving a message for an eventual destination exploits local knowledge to decide on its best next hop node among its current neighbours for reaching the eventual packet destination. When the forwarding opportunity does not exists (i.e., Non-availability of neibouring nodes in the transmission range or when the neighbours are not suitable for reliable communication) the node stores the message and waits for future contact opportunities with other nodes to forward the information. In this algorithm, we make each single node acts as a gateway. This makes opportunistic networks a more flexible environment than DTNs, and calls for a more radical revision of legacy routing approaches designed for the Internet.

Algorithm: ***Path Stability based Opportunistic Routing Algorithm (PSORA) for QoS enhancement in OBS***

The PSORA algorithm proposed for computing the optimal forwarder lists of all sources v's to the destination d based on link stability.

1: **//Initialization:**

2: S: = the set of all nodes except d

3: **for** each vertex v in S **do**

4: FLd[v]:= {v, d}

5: **if** Pr (v → d) > 0 **then**

6: Nd[v] := 1/Pr(v → d)

7: **else**

8: Nd[v] := ∞

9: **end if**

10: **end for**

11: **//Iterations:**

12: **while** S is not empty **do**

13: u: = node in S with smallest Nd[v]

14: remove u from S

15: **for** each neighbor v of u and v is in S **do**

16: FLd[v]:= **merge** (FLd[u], FLd[v])

17: Nd[v] := Nd-FLd[v]

18: **end for**

19: **end while**

20: **RETURN** FLd[v] for all nodes v

Initially let S be the set of all nodes except for a given destination node d.The MTS(Minimum Transmission selection) algorithm for computing the optimal forwarder list from any source node v 2 S to d is described in pseudo-code in Alg. 1. At each iteration of the algorithm, for any node v in S, FLd[v] records the (best) forwarder list from v to d discovered so far, and Nd[v] denotes the expected number of transmissions using the (currently best) forwarder list FLd[v]. It can be argued (see the next paragraph) that FLd[u] the optimal forwarder list for u with the minimum Nd[u] (among all possible forwarder lists for u to d), and it is therefore removed from S for further consideration in the future iterations. Given this, we now consider any neighbour node v of u that is still in S (step 15). If v is a neighbour of u, we merge the current best forwarder list FLd[v] with that of u, FLd[u], to obtain a new forwarder list for v (step 16). The merge operation combines and orders the nodes in FLd[v] and FLd[u] (except for v and d) based on the order at which these nodes are removed from the set S: the earlier a node w in FLd[u] or FLd[v] is removed from S, the higher the priority of w will be (clearly d has the highest priority, and v the lowest), and the new *merged* forwarder list FLd[v] is thus of the form {v, u, . . . , d}. We then update Nd[v] with the expected number of transmissions using this new merged forwarder list FLd[v], computed via eq.(3) (step 17). This procedure continues until the optimal forwarder list is computed for all nodes (i.e., until S is empty).By make use of this algorithm we always choose the best routing path to transmit the signal.

5. SIMULATION RESULTS AND DISCUSSIONS

5.1 SIMULATION ENVIRONMENT

The extensive simulation of PSEMQoS is conducted through ns-2 with the aid of NSF network which contains the topology of 30 nodes and 25 links with Jumpstart JIT signaling protocol as the base protocol. The simulation is carried out by letting the most loaded link of the NSF network to fail for analyzing the role of PSEMQoS in regaining the required QoS.Furthur, PSEMQoS is compared with OBSRWA(Optical Burst Switching reservation and wavelength assignment approach) and NFRMOBS (Novel Fast Restoration Mechanism for Optical Burst Switched networks) that reduces the number of required wavelengths to assign a different wavelength to each path in a set of overlapping paths (asynchronous PQP).Furthermore , we analyze the traffic pattern variations for all the schemes considered for measuring the performance of proposed technique through parameters namely Burst loss probability, jitter, Average Goodput and packet delivery ratio. In addition, The assumptions considered for carrying out the simulation are:

a) All physical links in the network are considered to be bidirectional with an allocation of 40 wavelengths per link.

b) The burst arrival process for the Optical Burst Switching reservation is considered to be modeled through Poisson burst duration process.

5.2 Performance Metrics

The Exhaustive comparative analysis of the devised PSEMQoS with OBSRWA and NFRMOBS was carried out based on the following evaluation metrics:

1. ***Packet delivery ratio***: It is the ratio of the number of packets received by the destination nodes to the actual number of

   packets generated by the source nodes.
2. **Jitter:** It is defined as the variation in latency that is measured over time by varying the packet latency across the burst

   Switching network.
3. **Burst loss probability**: It is defined as the ratio of the number of burst packets lost to the total number of burst packets received during a link failure of burst switching network.
4. ***Average Goodput*:** It is defined as the ratio calculated by dividing the maximum size of the transmitted file to the time required for transferring that particular file.

All the results of the simulations are obtained with 95% of confidence through batch mean method. The fault detection rate and update time for the simulation are considered to be 20 ms and 250 ms respectively.

5.3 *Performance Evaluation of* Path Stability based Enhancement Mechanism for QoS Provisioning (PSEMQoS) based on varying Load*:*

The performance of PSEMQoS is evaluated through comparative analysis with OBSRWA and NFRMOBS based on Burst loss probability, jitter, Average Goodput and packet delivery ratio by varying the load from 0.2 to 1.2 in increments of 0.2.

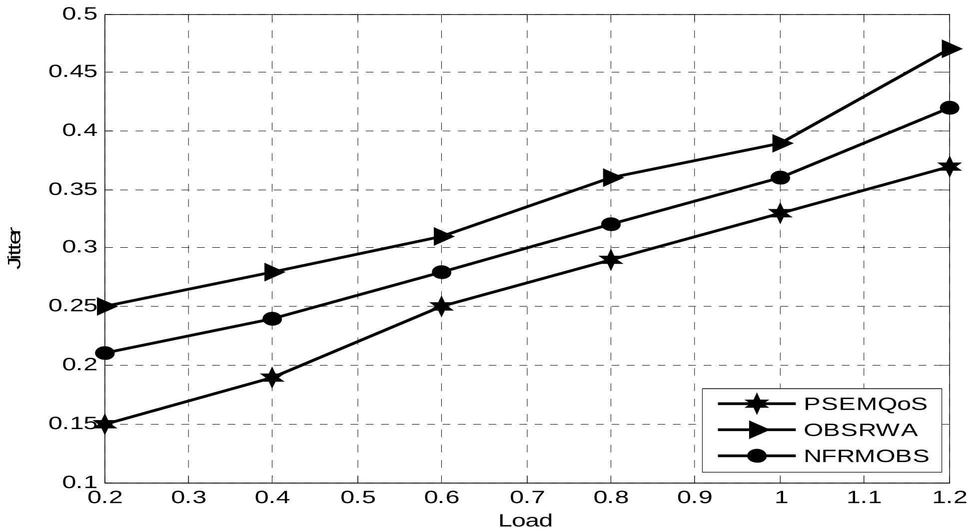

Figure 1 Comparative analysis for PSEMQoS based on varying load with respect to Jitter.

Figure 1 and Figure 2 presents the Comparative analysis for PSEMQoS based on varying load with respect to Jitter and Packet delivery ratio. From the simulation results obtained, it is transparent that PSEMQoS decreases the amount of jitter from 20% to 24% when compared to NFRMOBS and from 34% to 39% when compared to OBSRWA.This is due to the incorporation of efficient opportunistic routing and wavelength allocation scheme by PSEMQoS.

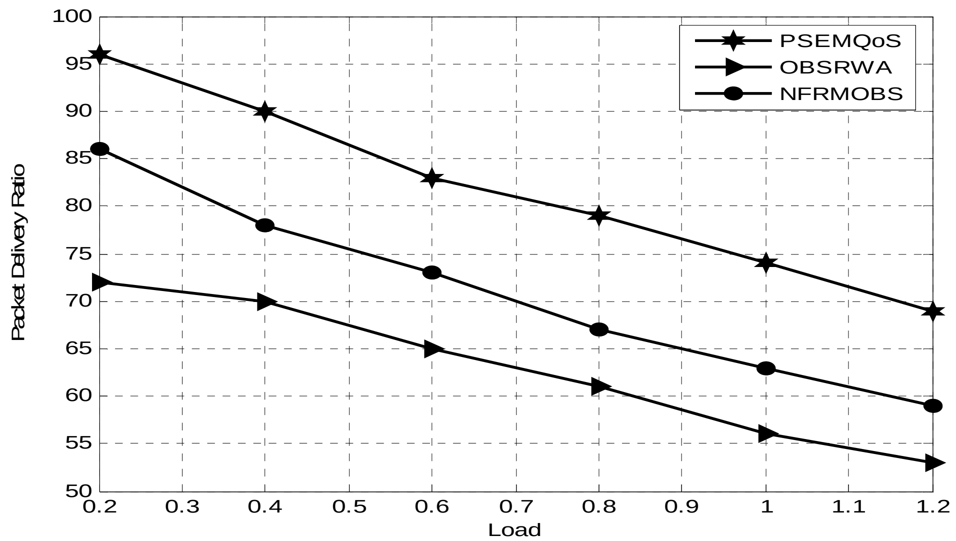

Figure 2 Comparative analysis for PSEMQoS based on varying load with respect to Packet Delivery Ratio.

In contrast, PSEMQoS improves the packet delivery ratio from 23% to 29% when compared to NFRMOBS and from 31% to 36% when compared to OBSRWA.Thus, in an average PSEMQoS decreases the jitter by 27% while increasing the packet delivery ratio by 23%.

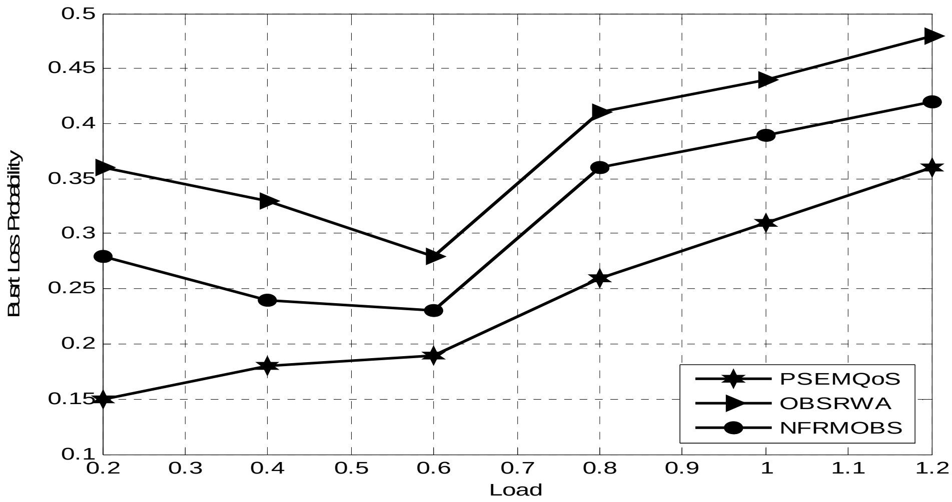

Figure 3 Comparative analysis for PSEMQoS based on varying load with respect to Burst Loss Probability.

Likewise, Figure 3 and Figure 4 present the Comparative analysis for PSEMQoS based on varying load with respect to Burst Loss probability and Average Goodput. From the simulation results obtained, it is evident that PSEMQoS decreases the amount of Burst Loss Probability from 18% to 23% when compared to NFRMOBS and from 22% to 31% when compared to OBSRWA.This is because PSEMQoS utilizes fast restoration process when compared to OBSRWA and NFRMOBS.

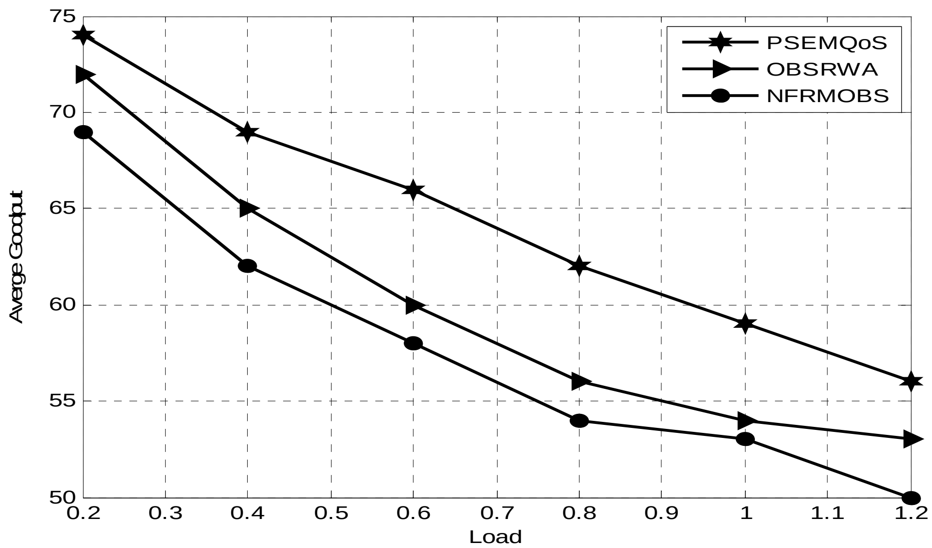

Figure 4 Comparative analysis for PSEMQoS based on varying load with respect to Average Goodput.

In contrast, PSEMQoS improves the Average Goodput from 27% to 34% when compared to NFRMOBS and from 36% to 39% when compared to OBSRWA.Thus, in average PSEMQoS decreases the bust loss probability by 21% while increasing the Average Goodput by 32%.

5.3 *Performance Evaluation of* Path Stability based Enhancement Mechanism for QoS Provisioning (PSEMQoS) based on Burst Loss Probability *:*

The performance of PSEMQoS is evaluated through comparative analysis with OBSRWA and NFRMOBS based on Average Goodput and packet delivery ratio by varying the Burst loss probability from 0.1 to 0.8 in increments of 0.1.

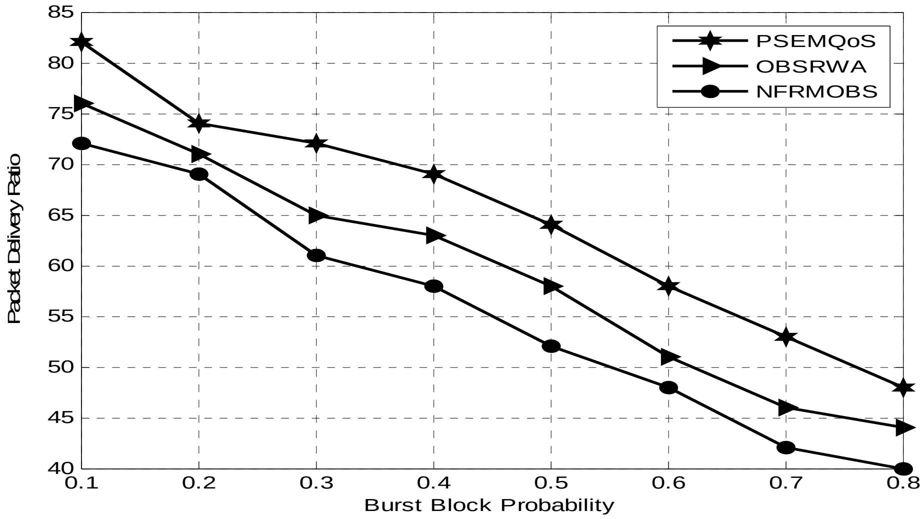

Figure 5 Comparative analysis for PSEMQoS based on Burst Block probability with respect to Packet Delivery Ratio.

Figure 5 and Figure 6 presents the Comparative analysis for PSEMQoS based on varying Burst Block Probability respect to Jitter and Average Goodput. From the simulation results obtained, it is transparent that PSEMQoS increases packet delivery ratio from 29% to 32% when compared to NFRMOBS and from 38% to 43% when compared to OBSRWA.

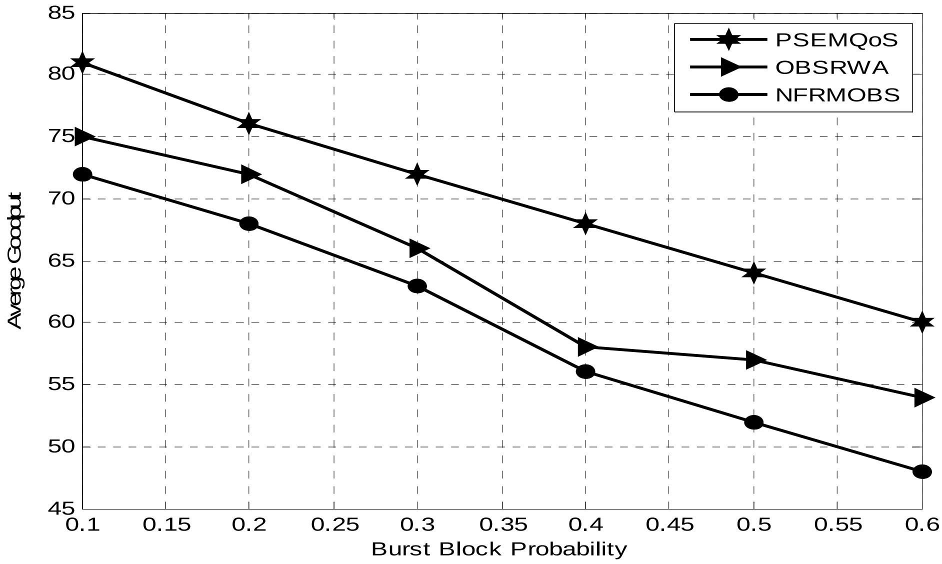

Figure 6 Comparative analysis for PSEMQoS based on Burst Block probability with respect to Average Goodput.

Similarly, PSEMQoS improves the Average Goodput from 21% to 31% when compared to NFRMOBS and from 26% to 36% when compared to OBSRWA.Thus, in average PSEMQoS improves the packet delivery ratio by 16% and Average Goodput by 32%.

5.3 *Performance Evaluation of* Path Stability based Enhancement Mechanism for QoS Provisioning (PSEMQoS) based on Burst Loss Probability:

The performance of PSEMQoS is evaluated through comparative analysis with OBSRWA and NFRMOBS based on packet delivery ratio and Burst loss probability by varying the amount of jitter from 0.02 to 0.1 in increments of 0.01.

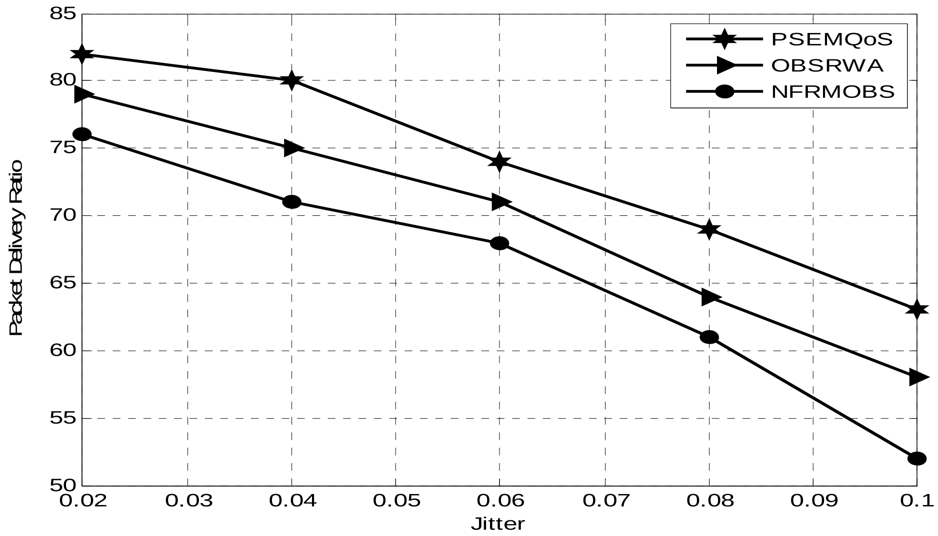

Figure 7 Comparative analysis for PSEMQoS based on varying amount of Jitter with respect to Packet Delivery Ratio.

Figure 7 and Figure 8 presents the Comparative analysis for PSEMQoS based on varying the amount of Jitter with respect to packet delivery ratio and Burst Block Probability. From the simulation results obtained, it is transparent that PSEMQoS increases packet delivery ratio from 21% to 27% when compared to NFRMOBS and from 29% to 33% when compared to OBSRWA.

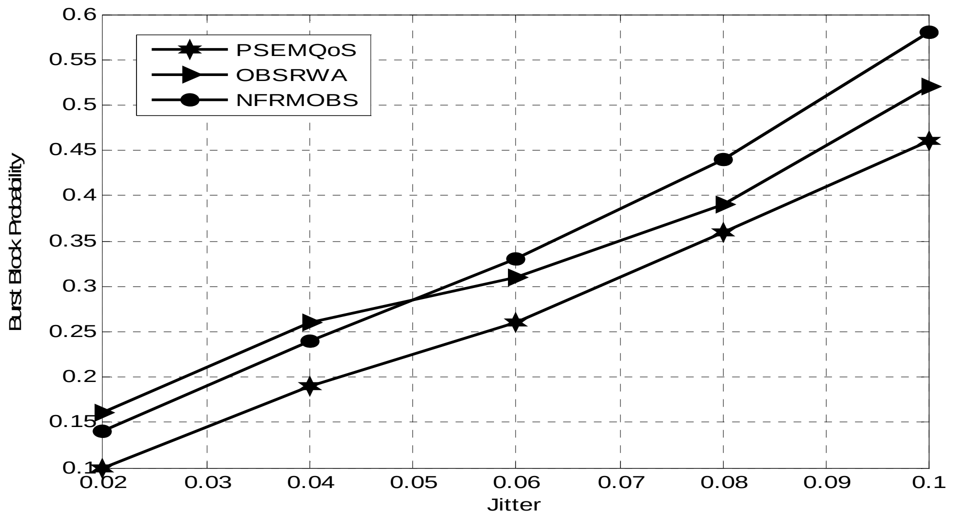

Figure 8 Comparative analysis for PSEMQoS based on Burst Block probability with respect to Packet Delivery Ratio.

In contrast, PSEMQoS decreases improves the Burst Block Probability from 19% to 16% when compared to NFRMOBS and from 23% to 29% when compared to OBSRWA.Thus, in average PSEMQoS improves the packet delivery ratio by 18% and the Burst Block Probability by 21% respectively.

6. CONCLUSION

In this paper, We present a Path Stability based Enhancement Mechanism for QoS Provisioning which handles both synchronous and asynchronous path based QoS provisioning based on the concept of distributed deflection routing. Furthur, this QoS provisioning approach (PQP) offers less Bust loss probability in the OBS network. The proposed novel opportunistic routing algorithm always chooses the best hop to transmit the video signal and also maintains a provision to record the user details about the request and the kind of response generated to that services .By maintaining this parameters we prevent the illegal use of services from the server to user. Furthermore, the proposed concept of multipath mechanism reduces the amount of the link failure that could occur when the router takes the alternating path to the server. Then the results of simulation show that video signals can be transmitted at less jitter, minimum loss probability and high packet delivery ratio. In future work, we plan to modify this paper as more no of users can select the video in dynamic manner by improving the MAC layer protocol.

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