Analysis of OBS Networks with Impatient Bursts and Server Breakdown

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Abstract. Burst contention is an important issue in Optical Burst Switching (OBS) networks. Various contention resolution schemes are available to resolve contentions. Buffering, deflection routing, wavelength conversion, segmentation and retransmission are normally used to resolve contention and to increase the number of bursts being processed in the network. In an optical burst switching network, when the burst arrives, it reserves the server for transmission if the server is available. If any contention occurs at the source node, bursts are either stored in the buffer for retransmission or leaves the network as impatient bursts. This causes burst loss in the network which in turn reduces the number of bursts being processed in the network. To avoid burst loss, buffering and retransmission techniques are combined and the effect due to the presence of impatient bursts and server breakdown on the bursts being processed in the network is studied in this paper.

Keywords: Optical Burst Switching; Buffering; Retransmission; Impatient bursts; Server Breakdown.

I. INTRODUCTION

For the past several years a significant amount of research [1] has been conducted in the area of optical burst switching networks. A major problem in OBS networks is wavelength contention which is the main reason for burst loss [2]. Contention occurs when more than one data burst try to reserves the same wavelength (server or data channel) in the network. Due to contention some of the bursts will be lost. The methods to solve contention like buffering, deflection routing retransmission and wavelength conversion are at burst level and a typical method for packet level is burst segmentation [3,4,5]. Buffering with Fiber Delay Lines are used to store bursts temporarily until output ports become available. Due to limited storage time it is not possible to store a large number of optical bursts. Wavelength Conversion avoids contention by converting one wavelength to the other and it improves the performance considerably. However it is expensive because it requires extra hardware. In Deflection Routing when a burst arrives at an OBS core node, if the primary path is not available it will be switched to an alternate path and the burst is distributed to its adjacent nodes. Retransmission method is proposed to provide a transmission without any burst loss by retransmitting the contending burst. In burst segmentation, a burst is divided into segments. Each segment may consist of a single packet or multiple packets and define the possible portioning points of a burst when the burst conflicts with other bursts. Network performance can be improved by combining two or more of the above techniques [6-10].

Several mathematical models with various aspects of contention resolution techniques have been proposed in the literature [9,11]. But these models ignored or paid less attention to the impatience of bursts travelling through the network. Queueing system with impatient customers has been studied by number of authors [12]. Loss probability of an M/M/1 optical FDL buffer of finite capacity and with impatient burst is given in [13]. In [14], the authors developed an analytical model to evaluate the performance of FDL as optical buffers to reduce the burst loss probability. In this, buffer is designed such that it can handle both deterministic delay and balking properties of FDLs. In [15,16], the authors proposed the concepts of two-phase queueing system with impatient customers and multiple vacations (multiple times going for maintenance activities). In [17], the authors explained about multi server queueing system (M/M/s/k) with finite capacity, balking, reneging and with exponential service distribution. If the burst waiting time in the buffer exceeds a particular amount of time, it leaves the network with impatience and considered as lost. In [18], the authors developed an analytical model to evaluate the performance of OBS node by applying optical buffers for retransmission of blocked bursts. The concept of M/M/1 queueing system with impatient customers and multiple vacations with exponential distribution is explained by the authors in [19]. In this work, buffering with retransmission is considered to increase the number of bursts being processed in the network for a single server queueing system (Mx/G/1/∞) with infinite capacity buffer, both balking and reneging, server breakdown (repair), reserved time, repeated maintenance activity of the server and with general service distribution.
II. ANALYSIS MODEL

Figure 1 shows the analysis model of the OBS network. In OBS networks, when the burst arrives it reserves the server for transmission if the server is available. If any contention occurs at the ingress node (source node) or the server is not available, bursts are either stored in buffer for retransmission or leaves the network forever as impatient bursts (balking). In this case, the link ingress node and core node is called first hop for all the bursts and the link between core node and egress node is called second hop. Once the incoming burst reserves the server and enters the network it will be transmitted successfully through both the hops to reach the destination. If there is any server breakdown [11], the burst remains in the same hop and the repair work starts instantaneously. After completion of the repair, the server accepts the new burst only after the successful transmission of available burst (reserved time). If contention occurs during retransmission then the bursts either comes to the buffer or leave the network forever (reneging) [17]. When there is no burst in the buffer, the server goes for maintenance activity [20]. On return from maintenance activity, if there is no burst in the network, again the server goes for another maintenance activity. This pattern continues until the server returning, finds at least one burst in the network. The number of maintenance activities is limited to a constant J (repeated maintenance activity). Impatient bursts are applied in the model to account for burst loss in the OBS. Reserved time is applied to avoid the loss due to server breakdown. Maintenance activities are done to update and enhance the performance.

A mathematical model is developed for the proposed scheme over OBS networks. Mx/G/1/∞ single-server queuing system with infinite capacity buffer is considered here. The model is developed only for single core node. However, this analysis can be extended to all the nodes in the entire network [21].

Consider a network in which packets arrive in batches called bursts according to Poisson process with rate λ bursts/second [7]. The burst size Y is a random variable with distribution function P(Y = k) = Ck, where k is a positive integer. The probability generating function C(z) and first two moments m1 and m2 [22].

If the server is free, then one of the arriving bursts reserves the server immediately and others join the buffer. If the server is busy all the bursts join the buffer with probability p or leave the network with probability q = 1 − p. The burst access from the buffer to the network is governed by an arbitrary law with distribution function R(x). If a new burst arrives first, then the retransmission burst cancels the attempt for reserving server and either returns to its position in the buffer with probability α or leaves the network with probability β = 1 − α.

Assume there are two available hops between source and destination, first hop (FH) and second hop (SH). All the arriving bursts pass through the first hop. As soon as the FH is completed the bursts may leave the network with probability δ or go for the SH with probability β(= 1 − δ). The service time of ith phase follows a general distribution with distribution function S(x) and the first two moments μ1 and μ2, i = 1, 2.

There may be server breakdown in the network while it is working. It is assumed that the lifetime of the channel in ith phase is exponential with rate αi. The repair time of the network failed during ith phase service is generally distributed with distribution function Δ(x) and the first two moments bi1 and bi2, i = 1, 2.

When the server breakdown occurs during ith hop of the transmission, the interrupted burst remains in the same hop with probability θi or joins the buffer with probability 1 − θi and keeps returning at times generally distributed with rate τi, i = 1, 2. After the completion of the repair, the server waits for the same burst to continue the transmission. The server is not allowed to accept new burst until the interrupted burst leaves the network [23]. Whenever the buffer becomes empty, the server leaves for maintenance activity for particular period. On return from maintenance...
activity if there is no burst in the buffer, the server go for another maintenance activity. This pattern continues until
the server returning from maintenance activity finds at least one burst in the network. Number of consecutive
maintenance activities is limited to \(J\) [24]. At the end of \(J\) maintenance activity even if the network is empty the
server is readily available in the network. The maintenance activities are generally distributed with distribution
function \(V(x)\) and \(N(t)\) denotes the number of bursts in the buffer at time \(t\).

Define the supplementary variables \(\xi_1(t)\) and \(\xi_2(t)\) as follows.

- If \(C(t) = 0\), \(\xi_1(t) = \) elapsed retransmission time
- If \(C(t) = 1, 2, \xi_1(t) = \) elapsed service time
- If \(C(t) = 3, 4, \xi_1(t) = \) elapsed service time and \(\xi_2(t) = \) elapsed repair time
- If \(C(t) = 5, 6, \xi_1(t) = \) elapsed service time and \(\xi_2(t) = \) elapsed reserved time
- If \(C(t) = j + 6, \xi_1(t) = \) elapsed maintenance activity time, \(1 \leq j \leq J\).

Let the functions \(\gamma(x)\), \(\mu_1(x)\), \(\mu_2(x)\), \(\Delta_1(x)\), \(\Delta_2(x)\) and \(\psi(x)\) are the conditional completion rates for
retransmission, first hop service, second hop service, breakdown during first hop, breakdown during second hop and
maintenance activity respectively. Then

\[
\gamma(x) = \frac{r(x)}{1 - R(x)}, \quad \mu_1(x) = \frac{s_1(x)}{1 - S_1(x)}, \quad \mu_2(x) = \frac{s_2(x)}{1 - S_2(x)}, \quad \Delta_1(x) = \frac{b_1(x)}{1 - B_1(x)}, \quad \Delta_2(x) = \frac{1 - B_2(x)}{1 - B_1(x)}\]

2.1 Steady State Distribution

For the process \(\{X(t), t \geq 0\}\) define the following probability densities

\[
\begin{align*}
E_0(t) &= P(C(t) = 0, N(t) = 0) \\
E_n(x, t) dx &= P(C(t) = 0, N(t) = n, x \leq \xi_1(t) < x + dx) \text{ for } x \geq 0, n \geq 1 \\
W_{1,n}(x, t) dx &= P(C(t) = 1, N(t) = n, x \leq \xi_1(t) < x + dx) \text{ for } x \geq 0, n \geq 0 \\
W_{2,n}(x, t) dx &= P(C(t) = 2, N(t) = n, x \leq \xi_1(t) < x + dx) \text{ for } x \geq 0, n \geq 0 \\
B_{1,1,i}(x, y, t) dx \ dy &= P(C(t) = 3, N(t) = n, x \leq \xi_1(t) < x, y \leq \xi_2(t) < y + dy), x \geq 0, n \geq 0, i = 0, 1 \\
B_{2,1,i}(x, y, t) dx \ dy &= P(C(t) = 4, N(t) = n, x \leq \xi_1(t) < x, y \leq \xi_2(t) < y + dy), x \geq 0, n \geq 0, i = 0, 1 \\
Q_{1,n}(x, y, t) dx \ dy &= P(C(t) = 5, N(t) = n, x \leq \xi_1(t) < x, y \leq \xi_2(t) < y + dy), x \geq 0, n \geq 0 \\
Q_{2,n}(x, y, t) dx \ dy &= P(C(t) = 6, N(t) = n, x \leq \xi_1(t) < x, y \leq \xi_2(t) < y + dy), x \geq 0, n \geq 0 \\
V_{j,n}(x, t) dx &= P(C(t) = j + 6, N(t) = n, x \leq \xi_1(t) < x + dx, x \geq 0, n \geq 0, 1 \leq j \leq J \\
\end{align*}
\]

where, \(i = 0\) means the interrupted burst is in service position and \(i = 1\) means the burst is not in the service position.

The system of steady state equations that governs the model under consideration is

\[
\begin{align*}
\lambda E_0 &= 0 \\
\frac{d}{dx} E_n(x) &= - (\lambda + \gamma(x)) E_n(x), n \geq 1 \\
\frac{d}{dx} W_{1,0}(x) &= - \left( p \lambda + \alpha_1 + \mu_1(x) \right) W_{1,0}(x) + \int_0^\infty B_{1,0,0}(x, y) \ dy + \int_0^\infty Q_{1,0}(x, y) \ dy \\
\frac{d}{dx} W_{1,1}(x) &= - \left( p \lambda + \alpha_1 + \mu_1(x) \right) W_{1,1}(x) + \int_0^\infty B_{1,0,0}(x, y) \ dy + \int_0^\infty Q_{1,1}(x, y) \ dy + p \lambda \sum_{k=1}^{n} C_k \\
\end{align*}
\]
\[
\frac{d}{dx} W_{2,0}(x) = -(p \lambda + \alpha_2 + \mu_2(x)) W_{2,0}(x) + \int_{0}^{\infty} B_{2,0,0}(x, y) \Delta 2(y) dy + 2 \int_{0}^{\infty} Q_{2,0}(x, y) dy
\]

with boundary conditions

\[
\frac{d}{dx} W_{2,n}(x) = -(p \lambda + \alpha_2 + \mu_2(x)) W_{2,n}(x) + \int_{0}^{\infty} B_{2,0,n}(x, y) \Delta 2(y) dy + 2 \int_{0}^{\infty} Q_{2,n}(x, y) dy + p \lambda \sum_{k=1}^{n} C_k
\]

\[
W_{2,n-k}(x), n \geq 0
\]

\[
\left( \frac{\partial}{\partial x} + \frac{\partial}{\partial y} \right) B_{1,i,n}(x, y) = -(p \lambda + \Delta_1(y)) B_{1,i,n}(x, y) + p \lambda \sum_{k=1}^{n} C_k
\]

\[
B_{1,i,n-k}(x, y), i = 0, 1; n \geq 0
\]

\[
\left( \frac{\partial}{\partial x} + \frac{\partial}{\partial y} \right) B_{2,i,n}(x, y) = -(p \lambda + \Delta_2(y)) B_{2,i,n}(x, y) + p \lambda \sum_{k=1}^{n} C_k
\]

\[
B_{2,i,n-k}(x, y), i = 0, 1; n \geq 0
\]

\[
\left( \frac{\partial}{\partial x} + \frac{\partial}{\partial y} \right) Q_{1,0}(x, y) = -(p \lambda + \tau_1) Q_{1,0}(x, y)
\]

\[
\left( \frac{\partial}{\partial x} + \frac{\partial}{\partial y} \right) Q_{2,0}(x, y) = -(p \lambda + \tau_2) Q_{2,0}(x, y)
\]

\[
\left( \frac{\partial}{\partial x} + \frac{\partial}{\partial y} \right) Q_{2,n}(x, y) = -(p \lambda + \tau_2) Q_{2,n}(x, y) + p \lambda \sum_{k=1}^{n} C_k Q_{2,n-k}(x, y), n \geq 1
\]

\[
\frac{d}{dx} V_{1,n}(x) = -(p \lambda + \psi(x)) V_{1,n}(x) + p \lambda \sum_{k=1}^{n} C_k V_{1,n-k}(x), n \geq 1; 1 \leq j \leq n
\]

\[
E_0(0) = \int_{0}^{\infty} \int_{0}^{\infty} V_{1,n}(x) \mu_2(x) dx + \delta \int_{0}^{\infty} \mu_1(x) dx + \int_{0}^{\infty} \mu_2(x) dx, n \geq 1
\]

\[
W_{1,0}(0) = \lambda C_1 E_0 + 0 \gamma(x) dx + \lambda \bar{q} \int_{0}^{\infty} E_j(x) dx
\]

\[
W_{1,0}(0) = \lambda C_{n+1} E_0 + \lambda q \sum_{k=1}^{n} C_k E_{n-k+1}(x)
\]

\[
\sum_{k=1}^{n} C_k E_{n-k+2}(x) dx + \int_{0}^{\infty} E_{n+1}(x) \gamma(x) dx, n \geq 1
\]

\[
W_{1,n}(0) = \beta \int_{0}^{\infty} \mu_1(x) dx, n \geq 0
\]

\[
B_{1,0,n}(x, 0) = \alpha_1 \theta_1 W_{1,n}(x), n \geq 0
\]

\[
B_{1,1,n}(x, 0) = \alpha_1 (1 - \theta_1) W_{1,n}(x), n \geq 0
\]

\[
B_{2,0,n}(x, 0) = \alpha_2 \theta_2 W_{2,n}(x), n \geq 0
\]

\[
B_{2,1,n}(x, 0) = \alpha_2 (1 - \theta_2) W_{2,n}(x), n \geq 0
\]

\[
\int_{0}^{\infty} B_{1,1,n}(x, y) \Delta_1(y) dy, n \geq 0
\]

\[
\int_{0}^{\infty} B_{2,1,n}(x, y) \Delta_2(y) dy, n \geq 0
\]
\[ V_{1,0}(0) = \oint_{0}^{1} W_{1,0}(x) \mu_{1}(x) \, dx + \oint_{0}^{1} W_{2,0}(x) \mu_{2}(x) \, dx, \quad n = 0 \]  
(24)

\[ V_{j,0}(0) = \oint_{0}^{1} V_{j,0}(x) \psi(x) \, dx, \quad j = 2, 3, \ldots J \]  
(25)

2.2 Solution of steady state distribution

After solving the above equations using supplementary variable technique we get the following results.

The probability generating function of the number of bursts in the buffer is

\[ P_{i}(z) = E_{0} + E(z) + W_{1}(z) + W_{2}(z) + \sum_{i=0}^{\infty} \left[ \sum_{j=0}^{J} B_{j}(z) + Q_{i}(z) \right] + \sum_{j=0}^{J} V_{j}(z) \]  
(26)

Where,

\[ E_{0} = \frac{z(1 - R^{2}(\lambda) \lambda)[z(T(z)-1) + C(z)T_{2}(z)]}{z^{2} - T_{1}(z)T_{2}(z)} \]  
(27)

\[ W_{1}(z) = \frac{\lambda E_{0} [z C(z) + T_{1}(z)(T(z)-1)][1 - S_{2}^{*}(k_{1} (p \lambda - p \lambda C(z)))]}{[z^{2} - T_{1}(z)T_{2}(z)](k_{1} (p \lambda - p \lambda C(z))} \]  
(28)

\[ W_{2}(z) = \frac{\lambda E_{0} \beta S_{1}^{*}(k_{1} (p \lambda - p \lambda C(z)))[z C(z) + T_{1}(z)(T(z)-1)][1 - S_{2}^{*}(k_{1} (p \lambda - p \lambda C(z)))]}{[z^{2} - T_{1}(z)T_{2}(z)](k_{2} (p \lambda - p \lambda C(z))} \]  
(29)

\[ B_{1}(z) = \frac{E_{0} \alpha_{1} [T_{1}(z)(T(z)-1) + z C(z)] [I - S_{2}^{*}(k_{1} (p \lambda - p \lambda C(z))] [I - B_{2}^{*}(p \lambda - p \lambda C(z))]}{[z^{2} - T_{1}(z)T_{2}(z)](p - p C(z))} \]  
(30)

\[ B_{2}(z) = \frac{E_{0} \beta \alpha_{2} [T_{1}(z)(T(z)-1) + z C(z)] [S_{1}^{*}(k_{1} (p \lambda - p \lambda C(z))] [I - B_{2}^{*}(p \lambda - p \lambda C(z))]}{[z^{2} - T_{1}(z)T_{2}(z)](p - p C(z))} \]  
(31)

\[ Q_{1}(z) = \frac{\lambda E_{0} \alpha_{1} (1 - \theta_{1}) [T_{1}(z)(T(z)-1) + z C(z)] B_{1}^{*}(p \lambda - p \lambda C(z))[1 - S_{1}^{*}(k_{1} (p \lambda - p \lambda C(z))]}{[z^{2} - T_{1}(z)T_{2}(z)](k_{1} (p \lambda - p \lambda C(z))} \]  
(32)

\[ Q_{2}(z) = \frac{E_{0} \beta \alpha_{2} (1 - \theta_{2}) [T_{1}(z)(T(z)-1) + z C(z)] S_{1}^{*}(k_{1} (p \lambda - p \lambda C(z))] [I - B_{2}^{*}(k_{2} (p \lambda - p \lambda C(z))]}{[z^{2} - T_{1}(z)T_{2}(z)](p \lambda - p \lambda C(z)) \]  
(33)

\[ V_{j}(z) = \frac{[V^{*}(p \lambda)]^{j-1} 1 - V^{*}(p \lambda (1-C(z)))}{p - p C(z)}, \quad 1 \leq j \leq J \]  
(34)

Using normalising condition, E0, the probability that the server is idle in the empty network can be obtained as

\[ E_{0} = F_{1} / F_{2} \]  
(35)

Where

\[ F_{1} = 2 - [p \lambda m_{1} \mu_{11}(1 + \alpha_{1} (b_{11} + \frac{1 - \theta_{1}}{\tau_{1}}) + p \lambda m_{1} \mu_{21}(1 + \alpha_{2} (b_{21} + \frac{1 - \theta_{2}}{\tau_{2}}))] - [R^{*}((\lambda) \]  

\[ + (1 - R^{*}((\lambda)) (m_{1} + q)] \]

\[ F_{2} = \lambda \mu_{11}(1 + \alpha_{1} (b_{11} + \frac{1 - \theta_{1}}{\tau_{1}}) + \beta \lambda \mu_{21}(1 + \alpha_{2} (b_{21} + \frac{1 - \theta_{2}}{\tau_{2}}))] [1 - R^{*}((\lambda))]q + D + p m_{1} R^{*}((\lambda)) + 1 \]  

\[ + (1 - R^{*}((\lambda)))(D - q) + \frac{D}{p m_{1}} F_{1} \]

and

\[ D = \frac{(1-V^{*}(p \lambda))^{j}}{(I-V^{*}(p \lambda))(V^{*}(p \lambda))^{j}} \]

\[ p \lambda m_{1} v_{1} \]
The probability generating function of the number of bursts in the network is
\[
P_z(z) = E_0 + E(z) + z \left[ W_1(z) + W_2(z) + \sum_{k=1}^{\infty} \left( \sum_{i=0}^{k-1} B_{k,i}(z) + Q_k(z) \right) \right] + \sum_{j=1}^{J} V_j(z)
\]  
(36)

The server is idle in non-empty network with probability
\[
E_0(1-R'(\lambda))m_1 + \beta \lambda m_1 p_{11}(1+\alpha_1 (1-\alpha_1^{-1} + b_{11}))
\]
\[
E(1) = E \left( \frac{\beta \lambda m_1 p_{21}(1+\alpha_2 (1-\alpha_2^{-1} + b_{21})) + D}{F_1} \right)
\]  
(37)

The server is busy with probability
\[
W = W_1(1) + W_2(1) = \frac{\lambda E_0(\alpha_1 + \beta m_2)}{F_1(1+D-(R'(\lambda)+1-(R'(\lambda))(m_1+q))}
\]  
(38)

The server is under breakdown with probability
\[
B = B_1(1) + B_2(1)
\]
\[
= \frac{\lambda E_0(\alpha_1 + \beta m_2)}{F_1(1+D-(R'(\lambda)+1-(R'(\lambda))(m_1+q))}
\]  
(39)

The server is on maintenance activity with probability
\[
V = \frac{1-(V'(\lambda))}{1-\lambda E_0(\alpha_1 + \beta m_2)} + \lambda E_0 v_1
\]  
(40)

Number of bursts in the buffer is given by
\[
I_q = \lim_{z \to 1} \frac{d}{dz} P_z(z) = \frac{D^2(1)N^3(1) - N^2(1)D^3(1)}{3[b^2(1)]^2}
\]  
(41)

where
\[
N^2(1) = 2[(1 - R'(\lambda))(D(\beta m_1 - \bar{q}) - 2p\beta m_1) - (1 + D + \beta m_1 + R'(\lambda)(l_1 + \beta l_2))]
\]
\[
N^3(1) = 3(g_3 + g_4 + g_5)
\]
\[
D^2(1) = -2p\beta m_1 F_1
\]
\[
D^3(1) = -3p(m_1l_1 + m_2 F_1)
\]
\[
l = \beta \lambda m_1 \mu_1 (1 + a_i \left( \frac{1 - \theta_i}{t_i} + b_{11} \right), i = 1, 2
\]
\[
l_3 = 2 - (g_1 + 2b_2 l_1 + b \beta_2) - \left( b_{11} + \beta \lambda (R'(\lambda) + (1 - R'(\lambda))(q + q_1)) - (1 - R'(\lambda))(2q m_1 + m_2)
\]
\[
g_1 = \mu_1 \left( \frac{\beta \lambda m_2 + a_i \beta \lambda m_2 b_{11} + p^2 \lambda^2 m_1 b_{12} + \beta \lambda m_2 (1 - \theta_i) + 2p^2 \lambda^2 m_1 (1 - \theta_i)}{t_i} \right) + \frac{2p^2 \lambda^2 m_1 (1 - \theta_i)}{t_i} (b_{11} + \frac{1}{t_i})^2, \quad i = 1, 2
\]
\[
g_3 = (g_1 + \beta(2b_2 l_1 + g_2) + 2p\beta m_1 l_1 + \beta l_2 + pm_1)((1 - A'(\lambda))(m_1 - \bar{q}) - m_1) - (l_1 + \beta l_2 + pm_1)(m_2 + 2m_1 - (1 - R'(\lambda))(2q m_1 + m_2))
\]
\[
g_4 = \frac{D}{m_1 v_1} (m_2 v_1 + \beta \lambda m_2 v_2) \left( (R'(\lambda) + (1 - R'(\lambda))(q + \beta m_1) - 2 \right) + D \left( (1 - R'(\lambda))(2q m_1 + \beta m_2 - 4p m_1) - 2 \right)
\]
\[
g_5 = pR'(\lambda)[m_1, l_1 + \beta(2b_2 l_1 + g_2) + 2m_1 l_1 + \beta l_2 + m_2 - (m_2 + 2m_1)(1 - (l_1 + \beta l_2) - m_1)]
\]

Number of bursts being processed in the network \( L_s \) under steady state is
\[
L_s = L_q + W + B
\]  
(42)

Using the above analysis, the number of bursts available in the buffer and in the network and the effect of arrival rate on the performance measures are calculated.

### III. SIMULATION RESULTS

For simulation, assume the retransmission time, service time, repair time and maintenance activity times to follow exponential distribution with respective rates \( \gamma, \mu_i, \Delta_i \) and \( \psi \) for \( i=1,2 \). The equations have been validated using MATLAB simulation. The performance measures such as number of bursts being processed in the network and probability that the server is busy have been presented in the Figures 2 and 3. We set the default parameters [25] as \( \lambda=1; \alpha_1=0.4; \alpha_2=0.4; \beta=0.6; \beta_1=0.5; \theta_1=0.4; \theta_2=0.4; \mu_1=5; \mu_2=10; \psi=5; \gamma=3. \)
In the simulation, conventional OBS method is compared with the analysed method for number of bursts being processed in the network with impatient bursts, reserved time and with server breakdown. Figure 2 shows that, number of bursts being processed in the network can be approximated with a linear function of arrival rate $\lambda$. The number of bursts being processed is more in the combined buffering and retransmission method. This characteristic improves the performance of a network to a great deal.

Figure 3 shows that the server is more busy when there is no server breakdown and there are no impatient bursts. The impatient bursts cause more burst loss in the network when there is increase in arrival rate of the network and so server busy probability is of low value.

IV. CONCLUSION

To avoid burst loss, buffering and retransmission techniques are combined and the effect due to the presence of impatient bursts and server breakdown on the bursts being processed in the network is studied in this paper. Simulation results are carried out to validate the performance of the network in terms of number of bursts being processed in the network with and without server breakdown.

V. REFERENCES


