INTERNATIONAL JOURNAL OF COMPUTERS COMMUNICATIONS & CONTROL
ISSN 1841-9836, 10(1):49-61, February, 2015.

Traffic Control Based on Contention Resolution in Optical Burst

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Abstract: Traffic control based on contention resolution process (TCCR) is proposed in this study as a quality of service (QoS) mechanism to offer service level agreement (SLA) for optical burst switch (OBS). QoS of the high and the low priority classes are issued upon their SLA. The first one is defined for real-time application as Internet protocol television (IP TV) and voice over Internet protocol (VoIP) while the other is for soft real-time service as Internet protocol remote terminal unit (IP RTU) based on IEC 60870-5-101/104 protocol. A combination of burst aggregation (BA), extra offset time, and fiber delay line (FDL) is utilized in TCCR to offer absolute service differentiation QoS to the high priority class. The experiments show TCCR can offer the high priority class of its satisfied SLA for both blocking probability and delay. It also relatively improves the performances of the low priority class bounded in its SLA because TCCR does not force to drop this class. The performances of TCCR are compared with the other techniques such as no class isolation and bandwidth allocation processes. The comparisons show TCCR gives the best solution of the defined SLA which enhances OBS performances and properly differentiates class of services.
Keywords: optical burst switching, contention resolution, voice and video applications, telecontrol application, service level agreement.

1 Introduction

Optical burst switch (OBS) is all-optical switching which makes connection setup with out of band signaling. OBS is a promising and future proofed technology for backbone network since it can support tremendous bandwidth and eliminate drawbacks of optical-electrical-optical (OEO) switching. For illustration, OBS requires lower power consumption than OEO switching. Also, it is a protocol transparent and data rate independent which brings about network scalability. Nowadays, network bandwidth consumption has been dramatically increased due to the new Internet protocol (IP) applications such as high definition television, interactive games, triple plays, and so on. Although huge bandwidth is provided, consumer needs are not restrained. In order to maintain customers' requirement and network utilization, quality of service (QoS) is a crucial factor to support multiple classes of services. Implementing QoS to IP network can be categorized into two models which are the integrated service (Intserv) and the differentiated service (Diffserv) models. Intserv model is per-flow guaranteed QoS. On the Internet network there are plenty of information flows; therefore, Intserv requires enormous amount of state information for all flows causing unscalability to the network. On the other hand, Diffserv model provides traffic differentiation based on per-hop QoS and specifies basic mechanisms on the way to treat packets. Difserv is defined into two services which are absolute service differentiation and relative service differentiation. The first one provides the worst case service to guarantee the application in each class whereas the second one relatively defines QoS based on other classes.

There are several research works in the area of OBS QoS based on contention resolution. Yoo et al. [1] propose offset time based QoS offering relative QoS for multi-class OBS. In this scheme, each class requires offset time differentiation for their class isolation. It also implements limited fiber delay line (FDL) for all classes to enhance each class's performance but not a purpose for class isolation. Although this scheme is effective to enhance network performances but it is not good enough to isolate multi-classes depending on their practical requirement. Therefore, more contention resolution mechanisms as burst aggregation (BA) or other techniques are required to provide the qualified QoS for multiple classes.

Shin and Yang [2] propose BA timer based scheme to isolate services between real-time and non real-time applications. In addition, Long et al. [3] also present BA adjustable timer and burst size based schemes to differentiate IP services into three classes. Both studies illustrate their schemes can offer relative QoS for the real-time application but they result in performance degradation of non real-time application. Moreover, both studies do not present FDL in OBS core nodes to reduce burst loss in the core network.

Cherif and Fatima [4] present a study of relative QoS oriented based on contention resolution by using FDL and deflection routing techniques. Although, they use various combinations of both schemes to reduce blocking probabilities of OBS; the major contribution come from FDL. The combinations of both schemes are also used as service differentiation of the two classes. However, the performances of the high classes are enhanced by those techniques but the low classes experience more contention due to the deflected bursts from the high class traffic. Moreover, lacking of BA and offset time schemes in this study yields limitation in OBS network enhancement. The study of absolute guaranteed QoS mechanism using BA timer and threshold based techniques is presented by Choi et al. [5]; however, this study is not proposed to isolate service differentiation classes. A proactive wavelength pre-emption technique supporting absolute QoS is proposed by Phuritatkul et al. [6] in order to guarantee QoS in absolute term for the high class. In contrast, the low class experiences more burst drops due to their wavelength preemption scheme. This scheme can guarantee the high class QoS but the mechanism is complex and it is not scalable for large networks.

Form the previous works, there are some openings based on providing QoS to OBS with contention resolution schemes. In this study, we focus on the study based on the two classes of traffic: the high and the low priority classes. We propose a new technique to offer absolute QoS with traffic control based on contention resolution (TCCR) applied to the high priority class. Because there is no electronic buffer device in OBS, the combination of the three contention resolution schemes in time domain as extra offset time, BA, and FDL are utilized in TCCR as QoS mechanisms to enhance OBS performances by reducing network blocking probabilities in both edge and core nodes. TCCR also gives distinctive service differentiation between the high and the low priority classes by allowing the high priority class to be controlled with the three mentioned mechanisms. Next, we compare our proposed schemes with an absolute QoS based on the IP QoS bandwidth allocation scheme [7] and also OBS implementing various contention resolution schemes with no class isolation.

We organize this research into four sections. The process of our proposed TCCR is demonstrated in the next section. Section 2 presents the proposed models and section 3 shows the experimental results. Lastly, the contribution is concluded in section 4.

2 Traffic Control Based on Contention Resolution Schemes

The technologies of optical memory and optical logic device are immature in this moment; therefore, contention resolution plays very important role for OBS to reduce burst losses in the network. Several contention resolution schemes are applied as QoS mechanisms. However, this paper highlights on the schemes in time domain which are extra offset time, BA, and FDL. Extra offset time scheme is a technique that allows extra timing accumulated to the original offset time for reducing burst losses in the network. BA electronically buffers several bursts at ingress node and smoothes burst traffics which lead to reduce network contention. FDL acts as a light buffer. It allows a contending burst traveling along optical fiber line in order to temporarily delay that burst before sending to an available channel. The detail of TCCR technique is illustrated in Fig.1. The high priority class (class 1) incoming traffics are queued in ingress buffers for BA

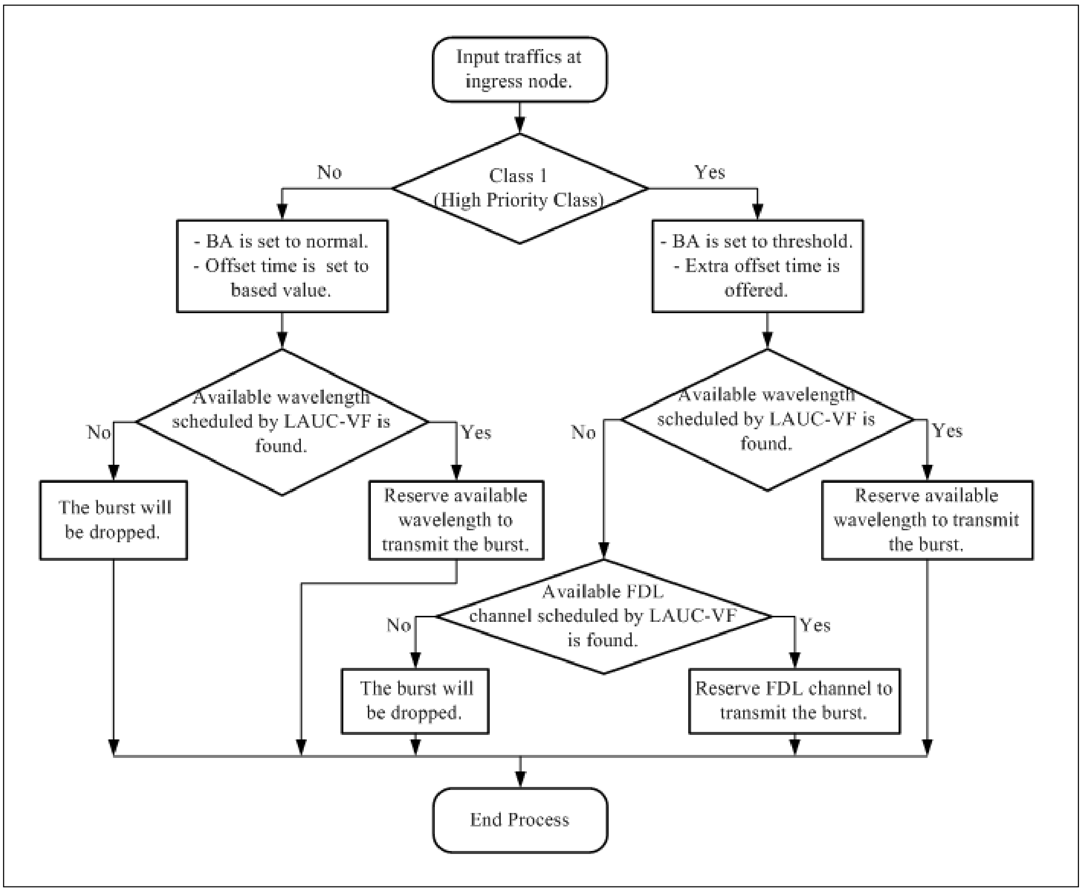

Figure 1: The process of TCCR

thresholds and their offset times are also set to be longer than their base values. In addition, at the intermediate nodes, if their control packets cannot reserve available channels for traffic class 1, then available FDL channels are selected. However, all mentioned contention resolution schemes are not provided for the low priority class (class 0) as to offer distinguished service differentiation between the two classes.

2.1 Quality of Service and Service Level Agreement

Service level agreement (SLA) is a key component of service level that service providers specify their performance agreement or QoS agreement to end users such as guaranteed delay and guaranteed bandwidth. In this paper we consider the two agreements for the two classes according to their QoS as follows.

Firstly, traffic class 0 is IP remote terminal unit (IP RTU) traffic based on IEC 60870-5-101/104 protocol [8]. This application is IP based information of supervisory control and data acquisition (SCADA) system for remote controlling and monitoring utilized in utility business. This application is very important for power grids, water treatment, distribution utilities and other utilities such as oil and gas pipeline utilities. This application is one of smart grid applications provides data acquisitioning, remote monitoring and remote controlling of the equipment in power grids including power plants and substations. In addition, this kind of traffic becomes more important for remote sensor and remote control applications based on IP network. For QoS aspect, this application requires soft real-time communication. The latency requirement is less than 1 s [9]. As this service is a request and response communication and its nature is designed for client and server concept, one session consumes very low bandwidth. It is approximately 100 kbps for one session stream [9]. Because its nature is master/slave soft real-time communication, when the server detects communication failure the server is able to restart pooling and recollect the information from the client. Therefore, no requirement based on blocking probability is defined for this application. However, this application is critical for operational works; blocking probability of this case shall be as minimal as possible which shall not affect IP RTU operation and overall network performance.

Secondly, traffic class 1 is assumed to carry both IP television (IP TV) and voice over IP (VoIP) applications which are real-time services in IP networks. They require high QoS to offer satisfied quality to users. Normally high grade of service network for voice application requires blocking probability less than 0.03 [10]. For video traffic, it needs blocking probability below 0.02 [2] [10]. Therefore, setting SLA of traffic class 1 in term of blocking probability to 0.02 will give satisfied blocking agreement to both IP TV and VoIP applications.

The standardized recommendations recommend one way end-to-end packet delay for video service of 150 ms to 400 ms [2] [10] and for voice service of 150 ms [10]. However, these values are too high for backbone network; there are some extra delays causing from other elements such as queuing delay and processing delay produced by edge nodes. In addition, propagation delays shall be taken in to consideration for network designing. Therefore, the maximum SLA for delay aspect shall be set in order to allow the network can tolerate more compensation on other extra delay. As the Sprint IP backbone network and some OBS and public frame relay networks offer one way delay of 31 ms [11], we adopt this idea to our OBS network to offer 31 ms as a delay SLA of traffic class 1 which can support high QoS to both video and voice applications.

2.2 Traffic and Network Models

The network for our study is 14-node and 21-link NSFNET [12] of which the topology and link propagation delays in second (s) are illustrated in Fig.2. The traffic capacity for each node pair of this topology is generated from the uniform random distribution from [12]. These capacities are scaled in order to make the maximum value of t_{ij} (the traffic demand between node i and node j) to be 400 Gbps. The traffic of each pair is generated by Poisson process with arrival rates of t_{ij}/B. For our case, B is average burst length duration and we set to 8 Mbits [13]. For the class isolation experiments, we conduct simulations based on the two traffic scenarios. Scenario 1: the traffic demands of class 0 and class 1 are both 50 percent of t_{ij} . Scenario 2: the traffic demand for class 0 is 30 percent and 70 percent of overall traffic is for class 1. In both scenarios, the traffic is simulated varied by the demand coefficients (k) which is altered from 0 to 1 with each step of 0.1.

Based on our traffic and network models, we deploy routing and wavelength assignment

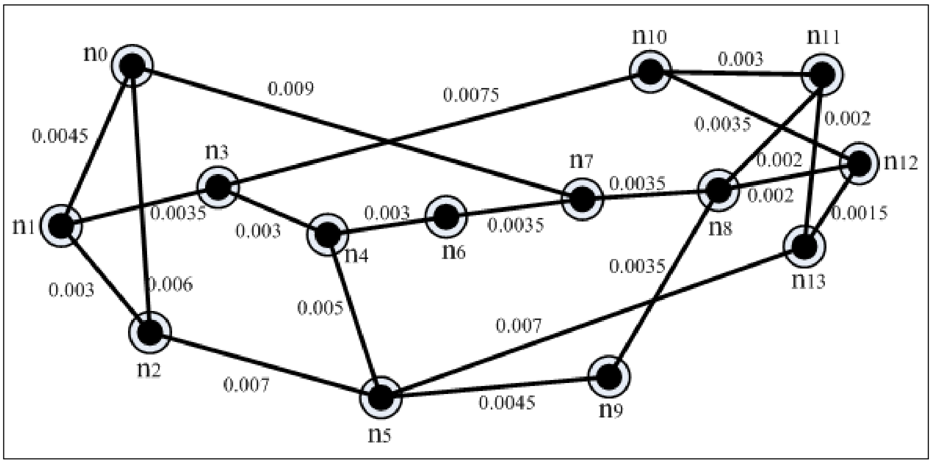

Figure 2: 14-node and 21-link NSFNET backbone network

(RWA) procedure from [14]. This network dimensioning procedure gives 98 wavelengths for unidirectional optical fiber cable as its optimum solution. We set 98 wavelengths for all data channels of this network and we assume the control channels' bandwidth is non-blocking. Each wavelength's capacity is 10 Gbps.

2.3 OBS Parameters and Simulation Models

Our OBS processing time is set to 80 μs [13] and the switching configuration time is 10 μs [5]. The simulation parameters are given as follows. BA is the first scheme of our consideration. BA is very important technique because it can smooth burst traffics and reduce burst losses which consequently improves link utilization [15]. Our BA is set by burst size threshold using burst length duration as it can ensure traffic smoothness and yields effectively reducing network blocking probability [15]. This scheme may introduce additional uncontrolled delay to the network when carrying light load traffics. However, this will not affect our study because we control the maximum delay in all experiments by controlling a target end-to-end delay below the offered SLA. Our basic burst size threshold is equal to the average burst length duration B in byte which is 1,000,000 bytes [13]. Each step of our BA experiment is varied with the multiple of B i.e. $1B$, $5B$ and etc. Our BA duration is quite high compared to the switching configuration time; therefore, link utilization of the network is not degraded [5]. In addition to BA, our based offset time of each route is the summation of total processing time of all nodes in that route and the switching configuration time [15]. Therefore, our extra offset time is varied incrementally from based offset time by multiple of b ($1b$, $2b$, and etc). We set $1b$ to the length of B in time domain (0.8 ms). Third, we implement FDL adopted from [16] to all nodes as illustrated in Fig.3. Each FDL parameter is varied with multiple of delay unit (D). $1D$ unit in time domain is set to 0.8 ms as same as $1b$ in the case of extra offset time scheme. The length of FDL is altered from $1D$ to $3D$. For $1D$ FDL in length, it takes a 160–km fiber cable; therefore, $3D$ is the maximum delay of 480–km fiber span implementing without an optical amplifier [17]. Lastly, all OBS experiments are simulated based on just enough time (JET) [18] and latest available unscheduled channel with void filling (LAUC–VF) scheduling [16] with shortest path routing. LAUC–VF requires full wavelength conversion; hence, our OBS is assumed full wavelength conversion [16].

From the literature reviews, Yoo et al. [1] propose the analytical formulations to calculate blocking probability of OBS implementing extra offset time and FDL schemes; however, they are applied for a single node analysis and do not give applicable results for the large network as our model. Du and Sbe [15] also propose analytical model to calculate network blocking probabilities

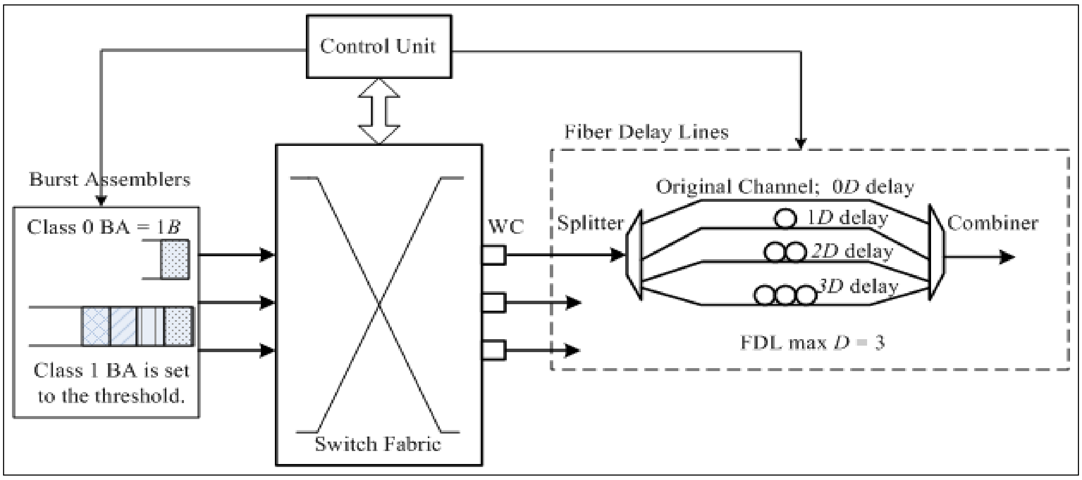

Figure 3: OBS node architecture

for BA in burst length threshold scheme. However, their analysis show variable BA thresholds do not affect network blocking probabilities because their offered loads remain the same. In contrast, they take a consideration of network blocking due to the congestion in control plane which is not applicable for our assumption. From those reasons, all experiments in this study are simulated based on ns-2 Simulator [19].

In order to demonstrate diverse aspects of our proposed TCCR process, we propose the performance comparisons between TCCR, bandwidth allocation service differentiation, and no class isolation models. In the bandwidth allocation service differentiation technique [7], the high priority class is offered dedicated network bandwidth just enough to give class 1 with its satisfied SLA. To illustrate, in scenario 1 both traffic class 0 and class 1 are 50 percent of total population in the network; however, 50 percent of all network bandwidth dedicated to traffic class 1 might not give the qualified blocking SLA to this class. Therefore, more reserved bandwidth for class 1 is required. However, the bandwidth given to traffic class 0 must be reduced because the bandwidth must be given to traffic class 1 to make it satisfied its SLA. Lastly, no class isolation model, all traffics are treated equally and their experiments are included based experiments (no contention resolution) and the simulations applied contention resolution schemes.

3 Experimental Results

Firstly, the repeated experiments are conducted for network provisioning to investigate the best parameters of our TCCR process with the results based on maximum load capacities ($k = 1$) shown in Table 1. The experiments are included the performances of class 1 applying each contention resolution scheme, the performances of class 0 with no contention resolution and also the simulations based on no class isolation comparable to those of service differentiation experiments are given.

Considering network condition in both scenarios 1 and 2, the studies in class isolation and no class isolation experiments show the same tendency. They can be concluded that BA is the best solution to reduce traffic class 1 blocking probabilities among the three techniques. FDL and extra offset time are the second and the third respectively. Although all schemes can enhance OBS performances, they introduce more delays to the network. If we compare the performances of traffic class 1 with the performances of traffic class 0, all contention resolution schemes can enhance the performances of traffic class 1 and it yields relatively reducing blocking probabilities

Table 1: Experimental results of one contention resolution schemes

Class	BA	Blocking Probability (x10^{-2})	Network Delay (ms)	Extra Offset Time	Blocking Probability (x10^{-2})	Network Delay (ms)	FDL	Blocking Probability (x10^{-2})	Network Delay (ms)
Traffic Scenario 1									
Class 0	-	2.76	10.72	-	3.00	10.35	-	2.95	10.35
Class 1	$5B$	2.38	14.46	$1b$	2.79	11.15	$1D$	2.77	10.36
Class 0	-	2.75	11.09	-	3.00	10.35	-	2.94	10.35
Class 1	$10B$	2.33	19.51	$2b$	2.78	11.95	$2D$	2.75	10.37
Class 0	-	2.71	11.46	-	3.00	10.35	-	2.93	10.35
Class 1	$15B$	2.16	24.55	$3b$	2.77	12.75	$3D$	2.74	10.37
Class 0	-	2.71	11.46	-	3.00	10.35	-	-	-
Class 1	$20B$	2.15	29.56	$4b$	2.77	13.55	-	-	-
Class 0	-	2.71	11.46	-	3.00	10.35	-	-	-
Class 1	$21B$	2.14	30.56	$5b$	2.77	15.15	-	-	-
Traffic Scenario 2									
Class	BA	Blocking Probability (x10^{-2})	Network Delay (ms)	Extra Offset Time	Blocking Probability (x10^{-2})	Network Delay (ms)	FDL	Blocking Probability (x10^{-2})	Network Delay (ms)
Class 0	-	2.82	10.42	-	3.00	10.35	-	2.97	10.35
Class 1	$5B$	2.44	14.21	$1b$	2.86	11.15	$1D$	2.84	10.36
Class 0	-	2.81	10.69	-	3.00	10.35	-	2.96	10.35
Class 1	$10B$	2.37	18.98	$2b$	2.85	11.95	$2D$	2.82	10.36
Class 0	-	2.80	11.06	-	3.00	10.35	-	2.95	10.35
Class 1	$15B$	2.34	23.73	$3b$	2.84	12.75	$3D$	2.81	10.37
Class 0	-	2.80	11.06	-	3.00	10.35	-	-	-
Class 1	$20B$	2.28	28.47	$4b$	2.84	13.55	-	-	-
Class 0	-	2.79	11.31	-	3.00	10.35	-	-	-
Class 1	$21B$	2.27	29.41	$5b$	2.84	14.35	-	-	-
Class 0	-	2.79	11.31	-	3.00	10.35	-	-	-
Class 1	22B	2.26	30.36	6b	2.84	15.15	-	-	-
No Class Isolation									
Class	BA	Blocking Probability (x10^{-2})	Network Delay (ms)	Extra Offset Time	Blocking Probability (x10^{-2})	Network Delay (ms)	FDL	Blocking Probability (x10^{-2})	Network Delay (ms)
-	-	3.01	10.35	-	3.01	10.35	-	3.01	10.35
	$5B$	2.52	13.57	$1b$	3.01	11.15	$1D$	2.89	10.35
	$10B$	2.45	17.58	$2b$	3.00	11.95	$2D$	2.87	10.35
	$15B$	2.43	21.58	$3b$	2.91	12.75	$3D$	2.86	10.36
	$20B$	2.42	25.58	$4b$	2.90	13.55	-	-	-
	$22B$	2.41	27.98	$5b$	2.90	14.35	-	-	-
	$23B$	2.41	28.77	$6b$	2.90	15.15	-	-	-

of traffic class 0 to be lower than the base experiment. In addition, the studies illustrate all contention resolution schemes can make traffic class 1 blocking probabilities lower than when we implement them to overall traffics with no class isolations. However, none of traffic class 0 blocking probability is better than those overall traffics treated by each contention resolution scheme. From the repeated experiments based on both class isolation and no class isolation, BA threshold is increased to the maximum limitation which produces the maximum delay just right under the defined delay SLA (31 ms). For the extra offset time scheme, the simulations are repeated with longer offset times until we hardly enhance network performance by this technique. In FDL, the experiments are simulated with the maximum limit of $3D$. Observing that the experiment based on the maximum threshold of each contention resolution is still unable to give class 1 satisfied blocking SLA (0.02); therefore, each two-combination of contention resolution schemes is conducted with the best solutions of which their delays are in boundaries learned from the experiences of one scheme implementations.

Table 2: Experimental results based on the combination of two contention resolution schemes

Traffic Scenario 1									
Class	BA	Blocking Probability (x10^{-2})	Network Delay (ms)	Extra Offset Time	Blocking Probability (x10^{-2})	Network Delay (ms)	FDL	Blocking Probability (x10^{-2})	Network Delay (ms)
Class 0	-	2.68	11.46	-	2.70	11.46	-	2.93	10.35
Class 1	$20B$ and $3D$	2.09	29.58	$20B$ and $3b$	2.14	31.06	$3b$ and $3D$	2.69	12.95
Traffic Scenario 2									
Class	BA	Blocking Probability (x10^{-2})	Network Delay (ms)	Extra Offset Time	Blocking Probability (x10^{-2})	Network Delay (ms)	FDL	Blocking Probability (x10^{-2})	Network Delay (ms)
Class 0	-	2.76	11.31	-	2.78	11.31	-	3.00	10.35
Class 1	$21B$ and $3D$	2.16	29.43	$21B$ and $3b$	2.25	30.72	$3b$ and $3D$	2.75	12.95
No Class Isolation									
Class	BA	Blocking Probability (x10^{-2})	Network Delay (ms)	Extra Offset Time	Blocking Probability (x10^{-2})	Network Delay (ms)	FDL	Blocking Probability (x10^{-2})	Network Delay (ms)
	-	3.01	10.35	-	3.01	10.35	-	3.01	10.35
	$22B$ and $3D$	2.28	28.10	$22B$ and $4b$	2.34	30.38	$4b$ and $3D$	2.83	13.56

To elaborate, the best solutions of traffic class 1, scenario 1 in the class isolation scheme of which their delays are in boundaries illustrated in Table 1 are the simulations applied with $21B$, $3b$, and $3D$ accordingly. For no class isolation, the best schemes are $23B$, $4b$, and $3D$. Thus, we conduct the experimentation of each two–combination scheme with those values. The results are presented in Table 2; however, these combinations are not able to make traffic class 1 meet blocking SLA requirement. However, there is some challenge for us to implement the third contention resolution scheme because there is some vacancy for extra delays. Therefore, the combination of the three contention resolution schemes based on TCCR is further conducted.

The parameters of the best results for all three schemes from Table 2 are selected for TCCR process. Their illustrations will be compared with the bandwidth allocation service differentiation technique (denoted BS). They are also compared with the experiments of no class isolation models (denoted No Class) which are the based experiment and the experiment applied contention resolution schemes. All mentioned simulations are conducted in both traffic scenario 1 (denoted

S1) and scenario 2 (denoted S2).

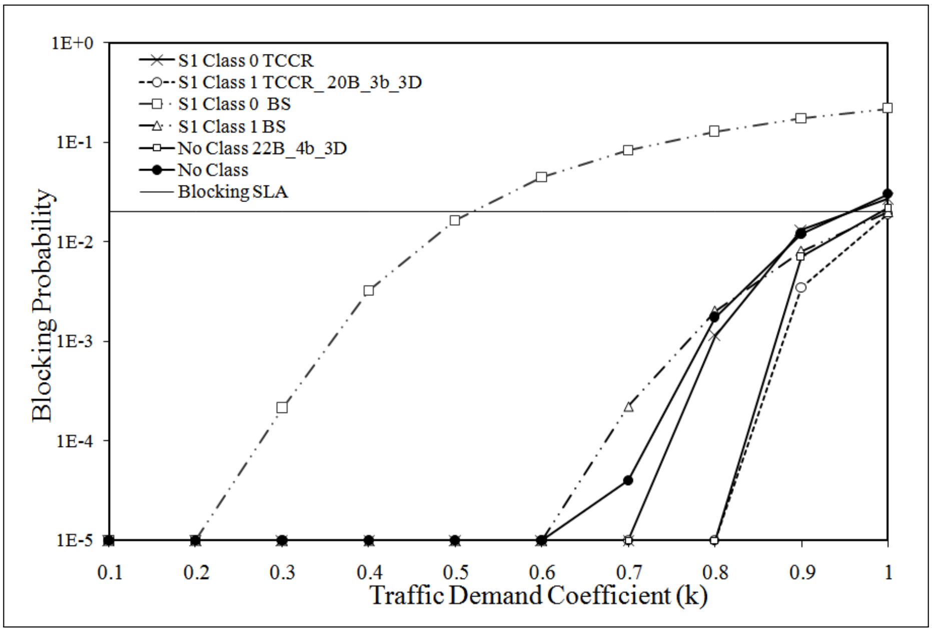

Figure 4: Average network blocking probabilities of TCCR, BS, and No Class for scenario 1

From the results illustrated in Table 2, traffic class 1 of scenario 1, the best solution is given by the combination of $20B$ and $3D$; however, this implementation is not be able to give satisfied blocking probability to traffic class 1. Therefore, the best solution of extra offset time scheme ($3b$) is combined to those two schemes in TCCR. As a result, TCCR with $20B$, $3b$, and $3D$ gives the most remarkable performance to this network as it can reduce blocking probability of the traffic class 1 under its SLA as illustrated in Fig.4. In addition, Fig.5 expresses the delay aspect of the results in Fig.4. The experiments show TCCR can very well improve services differentiation and class isolation between class 1 and class 0. Moreover, TCCR also indirectly improves blocking probability of traffic class 0 because the mechanism of TCCR does not make a decision to drop the low priority class but it selects various mechanisms to enhance the performance of the high priority class by utilizing network bandwidth, smoothing burst traffic and providing FDL channels for contending busts in the core network. Thus, more network resource can service traffic class 0 which leads to reduce this class's blocking probability. For BS, in order to give satisfied blocking SLA to traffic class 1, from the repeated experiments reffering to scenario 1, the simulations show it requires bandwidth of 57.70 percent of overall resource. Meanwhile the bandwidth of traffic class 0 is reduced to 42.30 percent. If we compare blocking probabilities of traffic class 1 between BS and TCCR processes, they have comparable performances at the maximum load capacity ($k = 1$). However, TCCR contributes better blocking probabilities than BS for all traffic capacities below that of $k = 1$. Moreover, blocking probability of traffic class 0 in TCCR process is very much better than in BS process. Also blocking probabilities of traffic class 0 in BS are higher than the base experiment because they are treated with very low amount of network bandwidth sharing.

Considering no class isolation with the three contention resolution schemes, it can enhance overall network performance. Form the experiences in Table 2, the combination of $22B$, $3D$ and, $4b$ is selected as they are the best solutions for this case. However, it cannot make overall network blocking SLA of class 1 within the limits. The repeated simulations with larger size of BA threshold and longer extra offset time are conducted to reduce blocking probability in this case but they introduce more delay beyond our delay limitation. Although traffic class 0 in TCCR process has little higher blocking probability than that of no class isolation deployed with the three contention resolution schemes, its blocking probability is acceptable. In contrast, blocking probability of traffic class 0 in BS process is quite high compared to no class isolation.

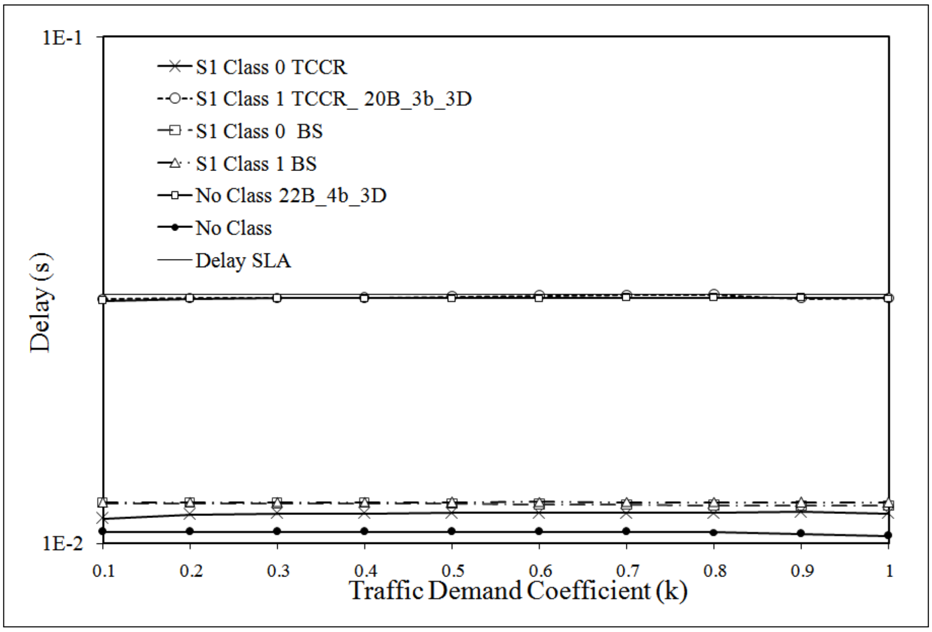

Figure 5: Average network delays of TCCR, BS, and No Class for scenario 1

In addition to the discussion of blocking performances, considering the delay aspect refering to Fig.5, traffic class 1 of both TCCR process and no class isolation with contention resolution experience highest average network delays but they are still under their delay SLA requirement. All extra delays are produced by the three contention resolution schemes. However, all traffic class 0 and class 1 in BS process including traffic class 0 of TCCR undertake very low delays because they are not deployed contention resolution scheme.

Fig.6 and Fig.7 illustrate the experiments of traffic scenario 2 based on the same experiments as scenario 1. In this scenario TCCR requires $21B$, $3b$, and $3D$ to give class1 satisfied blocking SLA. For BS, traffic class 1 requires 78.18 percent for the given class 1 blocking SLA which reduces offered bandwidth of traffic class 0 to 21.82 percent. In addition, the implementation of $22B$, $4b$, and $3D$ in no class isolation process is not able to give class 1 traffic with its satisfied blocking SLA. Also, traffic class 1 of TCCR process for scenario 2 has slightly higher blocking probability than in scenario 1 because of more traffic intensity but the results emphasize the same tendency conclusions as in scenario 1.

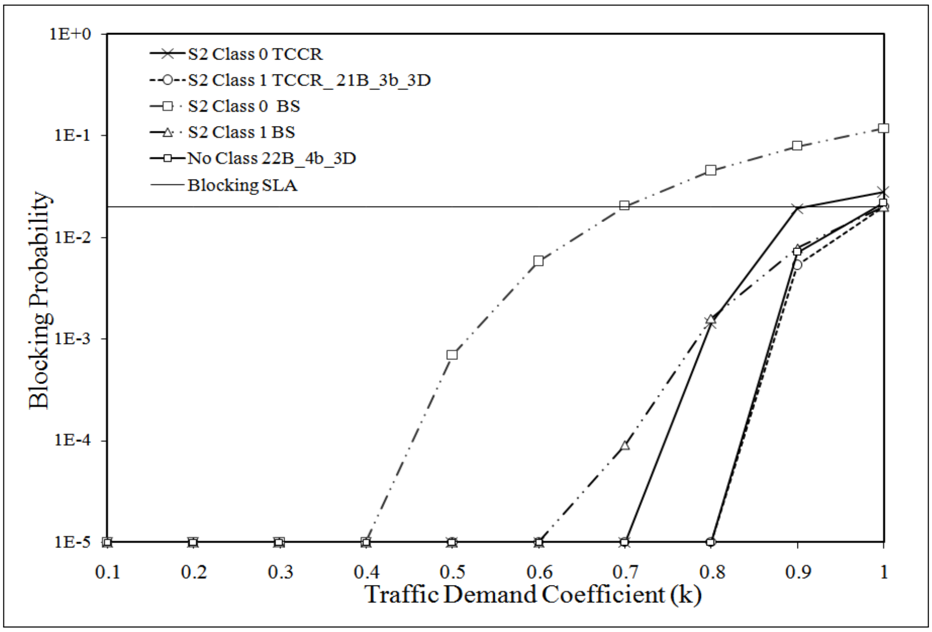

Figure 6: Average network blocking probabilities of TCCR, BS, and No Class for scenario 2

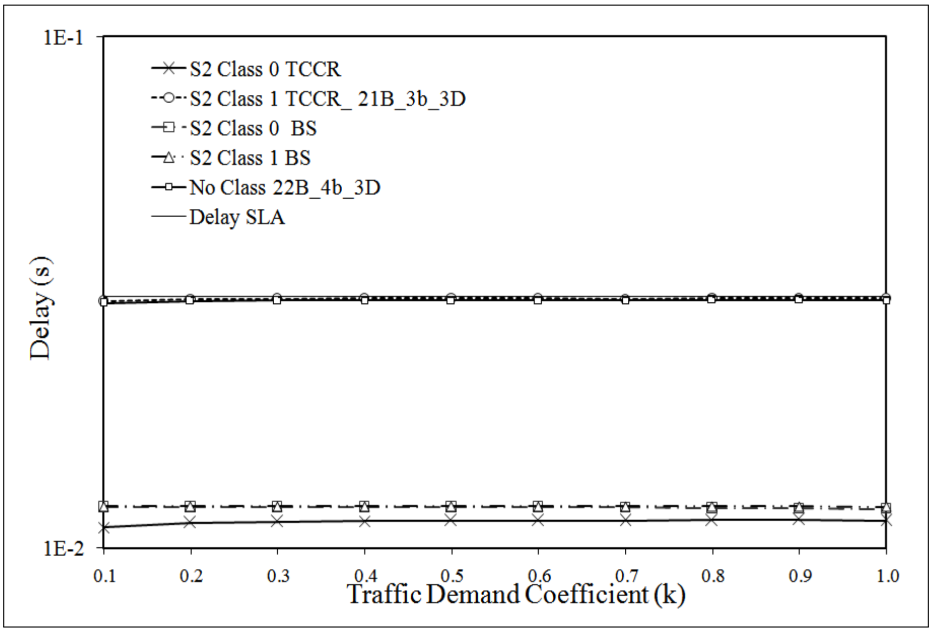

Figure 7: Average network delays of TCCR, BS, and No Class for scenario 2

4 Conclusions

This study proposes TCCR process which is a class isolation and service differentiation mechanism utilizing the three contention resolution schemes as BA, FDL, and extra offset time to control the performance of the high class traffic. This process can control the performance of this class very well by offering its satisfied SLA in both senses of network blocking probability and average network delay. In contrast, the illustrations of no class isolation deploying the three contention resolution schemes show they cannot offer the satisfied blocking SLA for the traffic in high class. In addition, BS process can give the traffic in high class satisfied its blocking SLA but this scheme results in very high blocking probability of the low class traffic. In summary, our OBS models require TCCR process to isolate the two classes and also differentiate their treatment according to their QoS. TCCR process can enhance the high class performance without dropping the low class packets; therefore, it yields indirect improvement of the low class traffic blocking probability which is also very well carried within its satisfied SLA. TCCR process can perform as an efficient QoS mechanism based on contention resolution and it can also give proper class isolation and service differentiation to both classes.

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