New CMT-SCTP with increased speed of data transmission

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Abstract

Communication protocols issues are one of the effective factors in communicated networks performance. One of challenging problem in CMT-SCTP which sends data by multipath concurrently is Receive Buffer Blocking. This problem has important role in data transmission speed in computer networks. In this paper, we propose a control method based on fuzzy logic so that can solve Receive Buffer Blocking problem in CMT-SCTP and has higher data transmission speed rather than other methods such as Buffer Splitting method. After proposed fuzzy logic designing by ANFIS logic and required data set, we evaluate our proposed method. Simulation result shows that our method improves data transmission speed compare to previous methods.

Keywords: CMT-SCTP, Fuzzy logic, Receive Buffer Blocking, network.

1. Introduction

Data centers represent the foundation of the Internet and computer services specially E-business service and high performance computing. Nowadays, development of web services is based on the increased size and complexity of the processed data. It is clear that the data centers continue to grow for higher performance and better availability. Hence, this remarkable growth in the data centers has motivated researchers to improve speed and capacity of data transfer [1].

Due to the heavy load of network traffic; TCP does not provide satisfactory performance in controlling congestion in data centers over the network. Thus, network suffers from loss of confidential data. Although, TCP is deployed into the data centers, it does not have the capacity to control the huge amount of data [2].

Fig 1 shows how to data transfer in CMT-SCTP protocol [5]. Using multi routes in data transfer contemporarily, if the properties of lines be different, for example one of the lines is wireless and another is ADSL, new challenges will be created using CMT-SCTP. Concept of dissimilar lines in CMT-SCTP is shown in Fig 2.

There are many challenges in CMT-SCTP protocol such as buffer blocking includes 2 models: sending buffer blocking and receiving buffer blocking that can affect on speed and performance of the protocol [7].

In this paper, we investigate receiving buffer blocking problem on dissimilar lines in CMT-SCTP protocol. As shown in Fig. 3, with transferring data via multi routes, the lines of data transfer have different properties such as different bandwidth, congestion and delay.

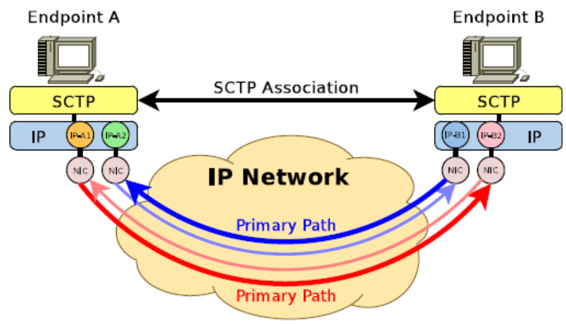

Fig. 1. Data transmission in CMT-SCTP

When the data are sent to receiver node, because of different types of line, data must be kept in one buffer so that all of required data are collected and then delivered to higher level. When one or multi data are sent with low speed and due to dissimilar lines, don't arrived to receiver buffer successfully, buffer blocking problem is created.

An example for the blocking issue at the receive buffer is shown in fig 2: endpoint A is trying to send all of its data chunks using unordered delivery to end point B [19].+

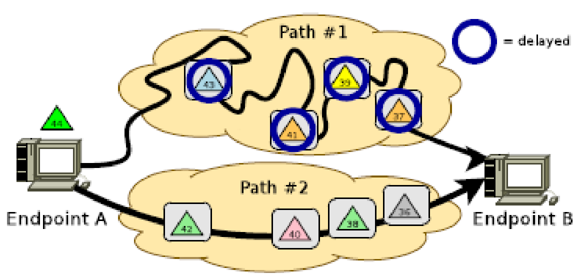

Fig.2. Receive buffer blocking

The line with high speed and bandwidth send another data to the receiver and save in receiver buffer. Therefore when desired data arrived at receiver, the receiver buffer hasn't required space so that the buffer is blocked. This problem is called receive buffer blocking as shown in Fig. 3 [8].

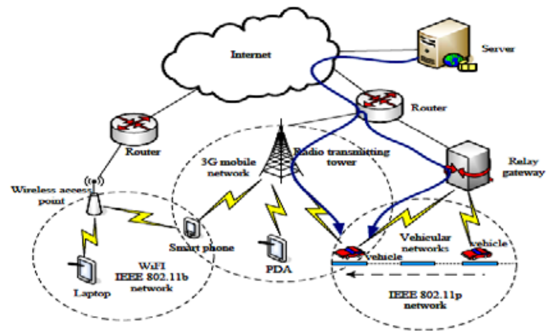

Fig. 3. CMT-SCTP in dissimilar lines

Two main methods have been proposed for receive buffer blocking problem so far. The main idea is dividing buffer into dissimilar lines and could solve this problem somewhat. Buffer splitting among dissimilar lines via random method is mentioned in last works. Proposing flexible solution such as fuzzy logic in order to allocate buffer to each line based on line's properties, cause that the lines with low congestion and bandwidth receive long buffer. Optimum buffer management cause to increase speed of data transmission. In order to send data via dissimilar routes contemporary by considering the most important effective factors on required buffer in every line, we proposed control method based on fuzzy logic.

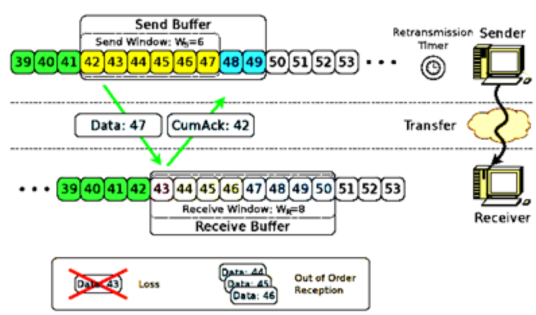

Fig.4. Receive buffer blocking in CMT-SCTP

According to our proposed method, we evaluate line's properties and then send these properties to fuzzy controller section so that decide about optimum amount of required buffer for every line.

2. Related Works

In spite of, the weaknesses of the standard TCP protocol to fit into the data centers are well known, it is impossible to do considerable changes on the standard TCP protocol [3, 4]. However, there are several alternative variants of TCP which are used in the areas where TCP cannot work. For example, SCTP which is a connection-oriented transport protocol that provides reliable stream oriented services similar to TCP. SCTP is especially designed to be used in situations where reliability and near real-time considerations are important as well as it is designed to run over existing IP/Ethernet infrastructure [5]. One of important related works about CMP-SCTP worked in [9] proposed a method for available multipath data transmission and [10] considered SCTP effect on HTTP and [11,12] proposed a method for multipath transfer with minimum bandwidth and delay in computer networks.

For solving receive buffer blocking problem, many works were presented such as NR-Sack and Buffer splitting. Related works for solving receive buffer blocking in CMT-SCTP are presented in Table 1.

3. Proposed Method

We explain our proposed method by using a designed example. The how to fuzzy controller design and required parameters are presented in this section.

3.1. The effective factors on amount of required buffer for every line

We need to consider the most important effective factors on amount of required buffer in dissimilar lines in CMT-SCTP. One of effective factors is bandwidth that has important role on the receiver in amount of required buffer for every line in CMT-SCTP. The more bandwidth of a line, the more buffers can be considered. Other considered factor in this paper is line congestion. Congestion and bandwidth are closely related. The more line congestion, the less bandwidth and amount of required buffer of a line.

Table 1. Proposed method for solving receive buffer blocking in CMT-SCTP

Proposed method	Main idea	Disadvantage
NR-Sack[13]	Change in response structure in a way that it becomes impossible to deliver data out of order to application layer	Unable to solve buffer blocking problem completely
Buffer splitting[14]	Buffer splitting to prevent buffer blocking	Unsuitable splitting of buffer
PF-CMT[15]	Change in transmission policies and present a method instead of CMT	It is small improvement and is a software way

3.2. Designing of Fuzzy Controller parameters

We extract different parameters such as the number of optimum roles, optimum membership function and type of membership function so that proposed fuzzy controller had required performance due to solve problem. In this paper, in order to solve receive buffer blocking in CMT-SCTP protocol, we proposed fuzzy controller using bandwidth and network congestion inputs which were explained in previous section. It can decide by fuzzy theory and at sequence make output that is required buffer for every dissimilar lines in CMT-SCTP protocol. Fig. 5 shows general view of proposed fuzzy controller components. In order to extract proposed fuzzy controller parameters, we use supposed example and extract required data for training and evaluate fuzzy controller based on properties of ANFIS that table 2 shows assumption of our design.

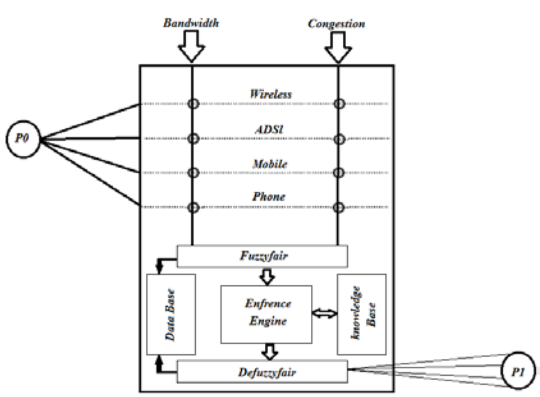

Fig. 5. Proposed fuzzy controller components

First, with the aim of achieving optimum parameters in designing fuzzy controller, 70 percents of available data set in table 4 are used for training fuzzy controller. Fig. 6 shows amount and coordinate of training data for best design in fuzzy control parameters. For proposed neural-fuzzy training, hybrid method with Epochs 100 and Error Tolerance 0.5 are used. Fig. 7 illustrate amount of decreased error in fuzzy controller training with different periods. After fuzzy controller training, designed control using 30 percents of remained data are evaluated (Fig. 8).

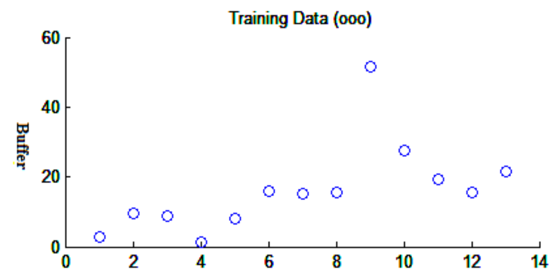

Fig.6. Training data in fuzzy controller design

As the Fig. 8. shows, the amount of digression in evaluated fuzzy controller is reduced based on amount of required buffer for every line.

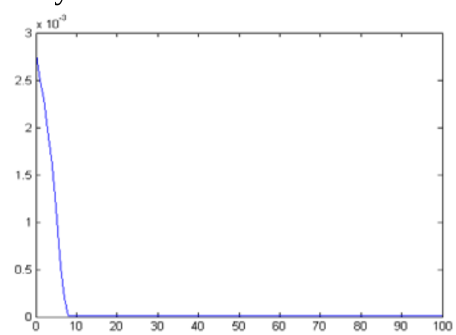

Fig.7. Fuzzy controller training and decreased error with increasing of epochs training

Fig. 9, 10 depicted input membership functions that were considered as Gussian. In our design, 25 optimum roles are extracted in Fig. 11.We extracted three-dimension fuzzy controller using Matlab software that is applied in our fuzzy controller design so that receive buffer blocking problem in data transfer contemporarily via multi dissimilar routes is solved(fig.12).

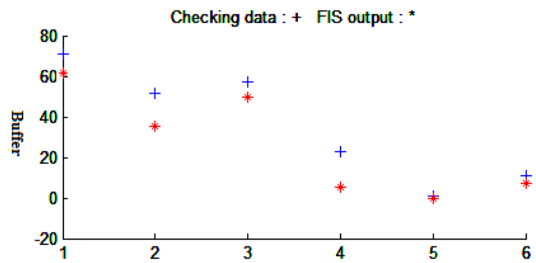

Fig.8. Considered data for construction of fuzzy controller

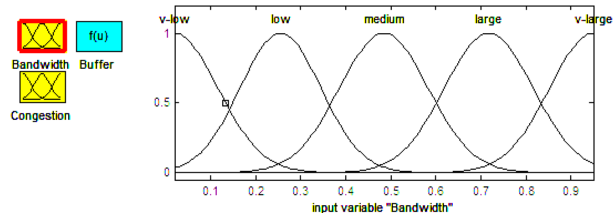

Fig. 9. Membership function in input bandwidth factor

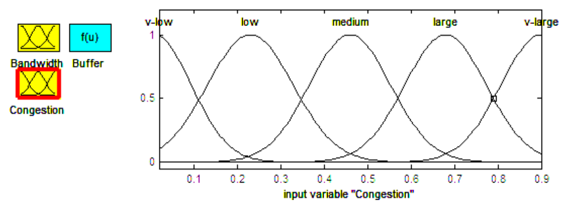

Fig. 10. Membership function in network congestion factor

Table 2. Assumptions for proposed design

Dissimilar lines	Line’s type	Percent of congestion	Percent of free bandwidth of line	Percent of required buffer
Line 1	Wireless	0.15	0.50	30.33
Line 2	ADSL	0.20	0.15	7.5
Line 3	Mobile	0.20	0.35	17.5
Line 4	Phone	0.40	0.5	12.5

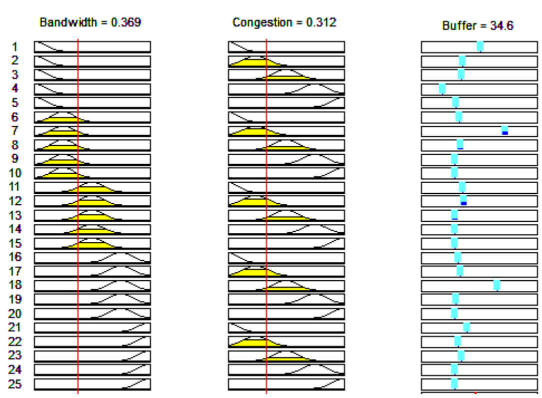

Fig. 11. Graphic view of used role set in Matlab

Table 3. Used data set for extracting of required buffer in every line in CMT-SCTP

Required buffer	Normalized buffer	Line's congestion	Free bandwidth
0.041	2.75	0.52	0.02
0.141	9.61	0.07	0.04
0.130	8.93	0.31	0.02
0.121	8.24	0.25	0.07
0.233	15.99	0.03	0.2
0.222	15.24	0.09	0.45
0.021	1.37	0.92	0.03
0.401	27.46	0.02	0.02
0.282	19.22	0.07	0.9
0.331	22.66	0.45	0.07
0.316	21.69	0.3	0.8
0.114	70.84	0.07	0.6
0.751	51.5	0.08	0.25
0.832	56.99	0.3	0.15
0.225	15.47	0.02	0.3
0.101	0.68	0.8	0.48
0.162	10.98	0.3	0.88
0.441	30.21	0.02	0.37

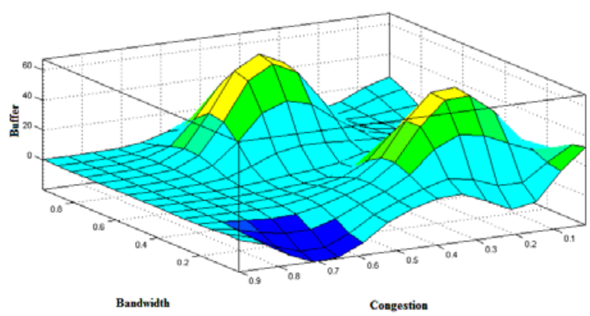

Fig.12. 3D view of designed fuzzy controller based on the desired input and output

4. Performance Evaluation of Proposed Method

In this section, we evaluated our method by using designed assumed example for input factor of proposed fuzzy controller and formula (1). According to desired data set in table 4, we evaluated proposed fuzzy controller. The results are shown in table 5.

Buffer splitting method used random buffer distribution among dissimilar lines therefore prevents from receive buffer blocking. In order to evaluate amount of allocated buffer for every line by buffer splitting method, we produce random number and allocate the buffer based on these numbers. The results are obtained in table 6.

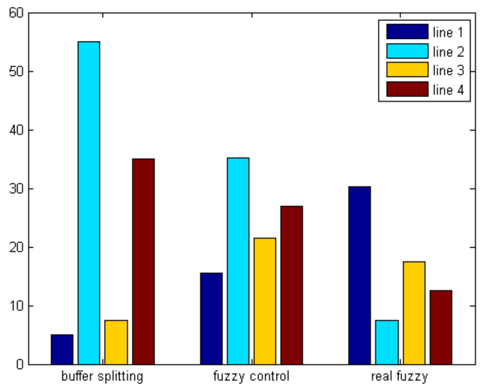

Fig. 13. Required buffer with Buffer Splitting and fuzzy controller

4. Result Analysis

We compare our proposed method with buffer splitting. The amount of required buffer is shown in table 5 and Fig. 13. Line 1,3 are compared based on speed of data transmission. Data transmission ability in these lines and amount of required buffer is higher than allocated buffer in buffer splitting method.

When receiver buffer is full, it ideals until deplete. If the buffer based on line's power is high, it can be prevented from line's ideal. At last transmission speed of line is increased. These lines transmit data in ideal time therefore more data are transmitted with high speed and are saved in receiver.

Amount of line's ideal and speed of line in ore method compared with splitting buffer method is shown in table 6 and Fig. 14. Speed of data transmission in our method is higher than buffer splitting. Achieved results in this paper can be important step to reach Quality of Service and HPC for communication systems and data transmission protocols.

Table 4. The result of data set evaluation on proposed fuzzy controller

Dissimilar lines	Percent of free bandwidth	Percent of congestion	Percent of buffer amount in fuzzy controller	Percent of required buffer in buffer splitting
Line 1	0.50	0.15	15.5	10.5
Line 2	0.15	0.20	35.1	55
Line 3	0.35	0.20	48.4	65.5
Line 4	0.5	0.40	35.5	40

Table 5. The result of data set evaluate on buffer splitting

Dissimilar lines	**Percent of free bandwidth**	**Percent of congestion**	**Percent of required buffer in buffer splitting**
Line 1	0.50	0.15	10.5
Line 2	0.15	0.20	55
Line 3	0.35	0.20	65.5
Line 4	0.5	0.40	40

Table 6. Increased ideal and decreased speed using buffer splitting and fuzzy controller

Method	Percent of average decreased speed	Percent of increasing ideal
Buffer Splitting	26.33	105.4
Fuzzy Controller	13.23	52.94

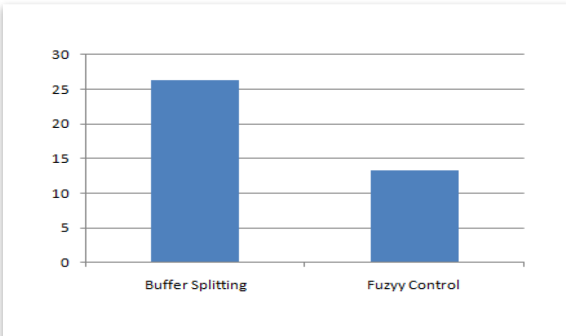

Fig. 14. Average of decreased speed of line in two methods

Conclusion

Receive Buffer Blocking problem is one of the important challenges in CMT-SCTP performance that Buffer splitting and NR-ACK has been proposed for this problem. In buffer splitting method, the buffer is divided into dissimilar lines in CMT-SCTP. In order to optimize buffer splitting among dissimilar lines, we proposed fuzzy controller. Using fuzzy controller, the buffer is divided into the lines optimally so that amount of receive buffer blocking reduces rather than buffer splitting method.

In this paper, our proposed method is compared with buffer splitting in terms of speed. The result shows that speed of data transmission with our proposed method is increased.

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