



## Managing the Buffer Occupancy in Multi-Input-Multi-Output Network Systems using SAAP Approach

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**Abstract**— *In Multi-input multi- output service, design of distributed explicit control flow procedures are being considered recently because of the abundance in wired/wireless applications. Several Multicasting approaches are proposed for achieving the proper flow control in MIMO systems. One of the approach is SPID (Distributed self-tuning proportional integrative plus derivate) and SPI (Distributed self-tuning proportional plus integrative) controller which provides low packet loss and high stability during transmission of data in MIMO systems. But this approach cannot manage buffer properly if the network has larger time delay. This paper proposes a SAAP technique for managing buffer even for larger time delay by sending the control packet acknowledgement back to sender when buffer capacity exceeds its limit. The simulations are performed and shown an improvement of 28% over SPID & SPI controller approach.*

**Keywords**— *Buffer Management, Multi-Input-Multi-Output Systems, Control Flow*

### I. INTRODUCTION

Unicast transmission mechanisms are effectively handled by several approaches in MIMO systems. In this transmission mechanism the packets are transferred from source to destination in sequential manner [1]. The problems associated with this approach are inconsistency, deadlocks, loss of packets, congestion and so on. To overcome the above problems multicast routing was designed for effective control flow in MIMO systems. The advantages of this approach are efficient transmission, proper traffic management, scalability and support for distributed applications. Multi cast approaches are very advantageous in distributed environment because it maintains branch point queue for packet forwarding and packet receiving from multiple systems. The literature presents one of the novel approaches of multi cast control flow called SPID and SPI controller which provides explicit control flow rates for multiple senders and multiple receivers in MIMO systems [2]. This paper is formatted as follows. In section 2, the related work of the paper is discussed. In section 3, the architecture of the existing system is discussed and in section 4 architecture of proposed technique is explained. In section 5 implementation of SAAP technique is discussed with algorithm and in section 6 performance of proposed technique is evaluated by simulation results. Finally in section 7 conclusion of the proposed technique and future work are discussed.

### II. LITERATURE SURVEY

Xi Zhang and Kang G. Shin [3] proposed feedback synchronization for measuring the delay and roundtrip time in multicast tree and probability distributions for measuring the bottlenecks of multicast. Kolarov and Ramamurthy [4] are further worked and verified for explicit control flow rate in available bit rate service. All these approaches are efficient for unicast transmission control flow and rate allocation.

Several multicast control flow schemes are proposed for handling explicit data distribution in MIMO systems. Multicast Feedback suppression Technique [5] is used for loosely coupled system for calculation of round trip time and doesn't require the prior information of group membership for providing prompt feedback. A TCP-friendly single rate multicast congestion control scheme [6] provides stability, scalability and fast response to changes in network. Multicast flow control for heterogeneous receivers [7] proposes an optimal control flow algorithm which solves the problems like huge data transfer and page ranking in multicast routing. Max-Min fair congestion control for multicast ABR services in Asynchronous Transfer Mode networks [8] are efficient for handling left over bandwidth and guarantees QoS services such as CBR and VBR. Max-Min fairness [8] allocates the available bandwidth to available bit rate connections. Priority service [8] helps the user to select their own traffic based on priority. Performance of hashing based schemes for multicast load balancing [9] are useful for handling large network systems in order to achieve high performance in multicast networks by applying load balancing technique. A control theoretic approach to the design of an explicit rate controller for ABS service [10] follows round robin queue technique for providing reactive control flow that doesn't require reserve bandwidth and designs the deterministic and stochastic models for single conversion of packet pair rate probing technique. This technique is helpful in achieving stable control flow scheme for transmission of data to distributed systems.

SPID and SPI controller [2] approach is one of the prominent techniques for multicast routing which is helpful in achieving the proper control flow in distributed MIMO systems. The major advantages of this approach are faster

response, low packet loss, high scalability, stability and efficient traffic management in distributed system [2]. This approach was connection oriented one and data was transferred in a fixed size packet format. It has slower response when the time delay between source and branch point is very high.

### III. EXISTING SYSTEM SPID & SPI ARCHITECTURE

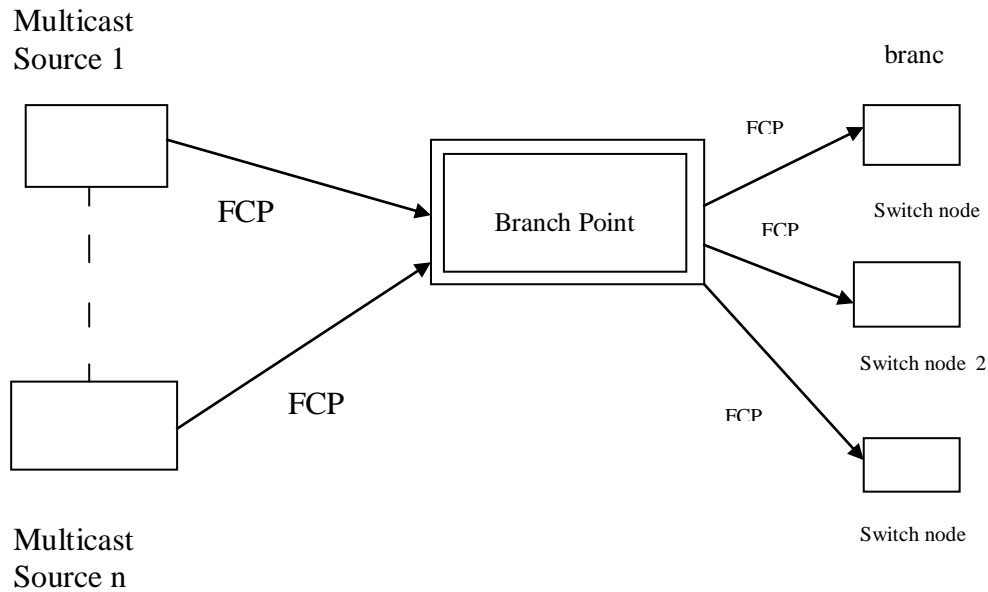


Figure1. MIMO system Multicast Transmission from Multiple points to Multiple points

- In MIMO systems multiple sources connect to the branch point.
- The branch point is responsible for managing the buffer and traffic of data and also responsible for transmitting the data to multiple destinations.
- SPID and SPI controllers are responsible for managing packet details in branch point. It will maintain the packet details as follows.
  - Forwards various control packets to multi destinations based on queue principle. Once the packet was reached to destination, it sends backward control packet signal with acknowledgement to branch point.
  - Once the acknowledgement was received the branch point frees the packet in queue.
- The advantage of this approach is even if the packet loss occurs; the transmission will not stop because the packet is maintained at branch point queue and retransmits the packet to destination based on negative acknowledgement.
- The time to deliver the packet to destination will be less even for packet loss because packet was transmitting from source point not from original source
- If the time delay between destination and branch point are more and the sender transmitting packets to branch point fastly the buffer will exceed its limit and causes the bottleneck at branch point. So, to overcome this problem SAAP technique has been proposed

### IV. PROPOSED SYSTEM SAAP ARCHITECTURE

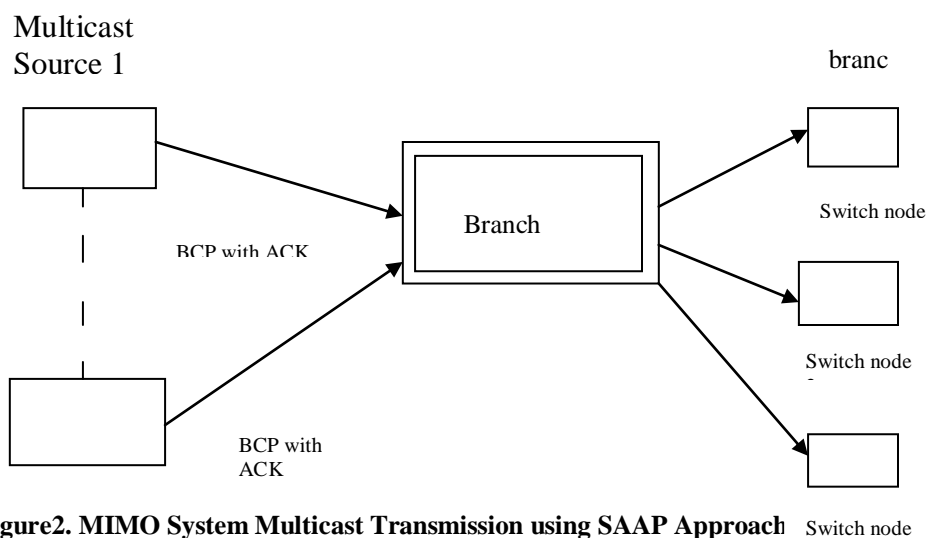


Figure2. MIMO System Multicast Transmission using SAAP Approach

SAAP approach will work same as SPID and SPI controller approach with additional features such as managing buffer with backward control packet mechanism along with acknowledgement to sender. This approach will work as follows:

- If the time delay between branch point and destination is more and fast sender transmitting the packets to branch point, the buffer will exceeds its limit and create the bottleneck at packet queue.
- Once the buffer is full and source transmits the packet to branch point, the branch point sends back the control packet with negative acknowledgement to sender (piggybacking).
- The sender will wait to transmit the packets further until the positive acknowledgement received from branch point.
- The advantages of this approach is as follows:
  - Buffer can be properly managed for larger time delays.
  - Provides synchronization between branch point and sender.
  - Manages the traffic between multiple senders, branch point and multiple receivers.
  - Avoids the deadlock situation

### V. SAAP IMPLEMENTATION

SAAP technique is mainly focused on buffer management at branch point which receives multiple inputs from MIMO distributed systems.

The Buffer occupancy of particular node 'i' is given by

$$a_i(k+1) = SAAP_{x_i} \{ (a_i(k) + \sum_{m=1}^q R_q P_q (K - L_i) - T_i) \} \quad (1)$$

Where  $x_i$  is the Buffer Size

$a_i$  is the Buffer Occupancy Of node i at slot k

$e_i(k)$  is the receiving rate of receiver i at time k

$$R_q = \begin{cases} 0 & \rightarrow \text{if } q \text{ is not in active state} \\ 1 & \rightarrow \text{if } q \text{ is in active state} \end{cases}$$

$$SAAP_{x_i} \{ a_i \} = \begin{cases} x_i, & a_i > x_i \\ a_i, & 0 \leq a_i \leq x_i \\ 0, & a_i < 0 \end{cases}$$

$$a_i(K+1) = a_i(n) + \sum_{m=1}^q R_q E_q (K - L_i) - T_i \quad (2)$$

#### ALGORITHM

- Packets are transmitted from branch point to destination by using QUEUE principle.
  - If the branch point sends the packet  $P_i$  to corresponding destination, and receives positive acknowledgement from destination then  
Set  $R_q = 0$
  - Else  $R_q = 1$
- IF  $R_q = 1 \ \&\& \ Buffer_{limit} > Buffer_{size}$  then
  - Sends the control packet  $P_j$  back to the corresponding sender along with the negative acknowledgement indicating that the buffer exceeds its limit.
- Else  
Branch point sends the positive acknowledgement to sender for transmission of data.

### VI. PERFORMANCE EVALUATION

The performance of the multicast transmission is evaluated as comparison between sender transmission rate for SPID controller and SAAP approach and also comparison of queue overhead on packet loss for SPID controller and SAAP approach.

#### A. SENDER TRANSMISSION RATES COMPARISON

The comparison table for SPID sender transmission rate and SAAP sender transmission rate over time is as follows: Recommended font sizes are shown in Table I.

Table I : Comparison table for Transmission rate on different approaches

Time(msec)	SPID Controller sender Transmission rate for single group node	SAAP sender Transmission rate for single group node
0	10	10
50	20	25
150	40	51
500	60	74

750	72	89
1000	85	106
1500	145	180
2000	182	224

The following graph illustrates the comparison between SPID controller sender transmission rate and SAAP sender transmission rate.

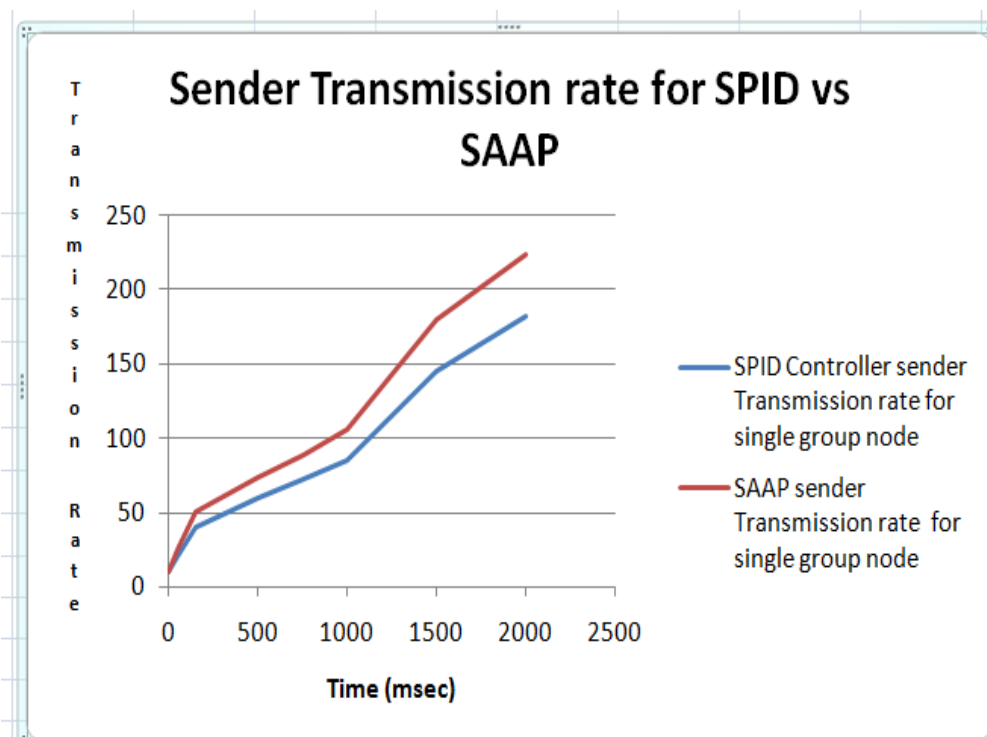


Figure I. Graphical Representation for Time and Transmission Rate

### OBSERVATIONS

1. The simulations are performed on Opnet.
2. The transmission rate from sender to branch point of SAAP is almost 25% efficient than SPID controller approach from the simulation values.
3. Hence efficient transmission rate from sender to branch point is achieved by proposed approach

### B. QUEUE OVERHEAD COMPARISON

The comparison table for SPID Queue Overhead and SAAP Queue Overhead is as follows:

Table II : Comparison table for Queue Overhead on different approaches

Packets Transmission	Queue Overhead on SPID Controller (percent)	Queue Overhead on SAAP Approach (percent)
30	6	5
50	8	6
150	16	12
500	36	26
750	39	28
1000	44	32

The following graph illustrates the comparison between SPID controller Queue Overhead and SAAP Queue Overhead.

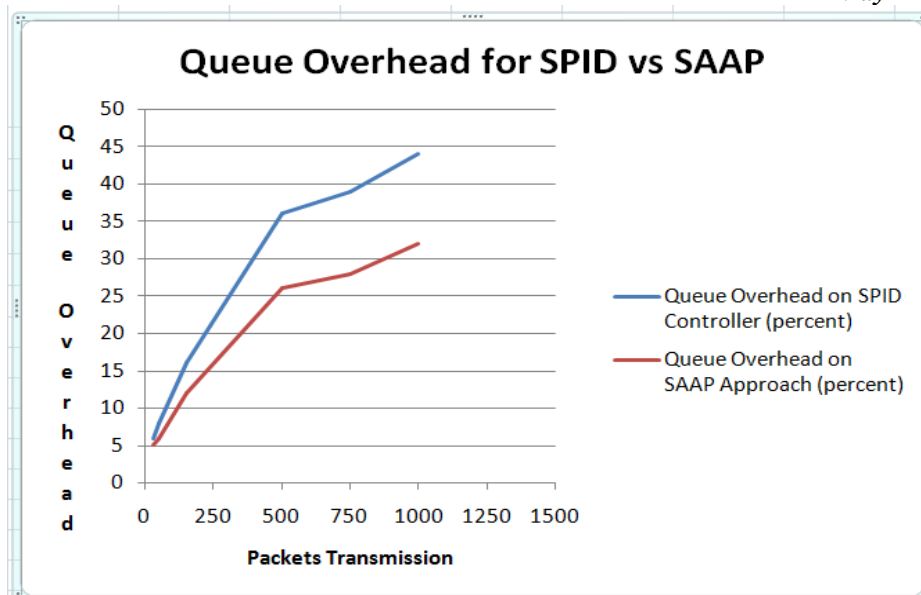


Figure II. Graphical Representation for Packet Transmission and Queue Overhead

### OBSERVATIONS

1. The simulations are performed on Opnet.
2. The queue overhead at branch point of SAAP is almost 28% efficient than SPID controller approach from simulation values.
3. Hence the queue overhead is reduced by the proposed approach

### VII. CONCLUSIONS

This paper presents the SAAP approach which uses backward control packet mechanism with acknowledgement for buffer management at branch point. This approach is very advantageous when time delay of delivering the packet between branch point and destination is more and also provides additional features like deadlock avoidance, synchronization, Queue overhead reduction, steady transmission of packets. Simulation results demonstrate that SAAP approach is 28% efficient than SPID controller approach. The limitation of this approach is sender has to wait more time until the positive acknowledgement has been sent by branch point and is not applicable for broadcast networks.

### VIII. ACKNOWLEDGMENT

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