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Time Restraint Tractable Aggregation Scheme for Beneficial Video Transmission over WLAN

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Abstract: Presently, IEEE 802.11n is the latest WLAN standard that is deployed across the world. IEEE 802.11n MAC layer is designed to achieve higher throughput up to 100 Mbps. The utility of video applications over WLAN has increased greatly in today's years. Real time video applications like video-conferencing are mainly the time-bounded application. Whereas, A-MPDU frame aggregation process of IEEE802.11n focuses on achieving higher throughput by aggregating the frames with reduced overhead. Aggregation process takes the time to aggregate the frames which are not advisable for the critically time bound applications. Hence, a conflict arises for transmitting the video application over the widely used WLAN standard. In this study, we propose a time restraint tractable aggregation scheme for video transmission that aggregates the frames within the desirable time interval. To do this, proposed methodology adds less number of frames based on the frame's delay threshold and traffic congestion. H.264/SVC video codec is used for the experimental evaluation. Our experimental result shows that, the proposed methodology is providing better results in term of end-to-end delay, jitter and PSNR. Thus for achieving better QoS, proposed time restraint tractable aggregation methodology can be used for video transmission over WLAN.

Key words: IEEE802.11n, frame aggregation, A-MPDU, QoS, video over WLAN, methodology

INTRODUCTION

The main objective behind the development of IEEE 802.11n WLAN standard is to achieve higher data throughput (Xiao, 2005; Perahia, 2008). Various amendments are addressed at the physical layer and Medium Access Control (MAC) layer of IEEE 802.11n to achieve the higher throughput. The enhancements in IEEE 802.11n MAC layer was done to support higher data rates by adopting the legacy WLAN Enhanced Distributed Channel Access (EDCA) functionalities. Multiple Input Multiple Output (MIMO) technology is introduced at the physical layer to achieve the higher throughput.

Emphasizing at physical layer alone cannot provide the higher data throughput. MAC layer has its own limitations as the extra overheads at the MAC layer reduces the overall network throughput (Ginzburg and Kesselman, 2007; Pokhrel *et al*., 2014). To overcome the limitations at MAC layer, various enhancements are introduced in 802.11n MAC layer such as frame aggregation, reverse transmission and block acknowledgment.

Frame aggregation is introduced as the key feature to improve the MAC efficiency. In frame aggregation process, number of frames are aggregated to seem like a single large frame by reducing the overheads data (Kim *et al*., 2008; Wang and Wei, 2009; Kolap *et al*., 2012a, b). In 802.11n, frame aggregation is of two types, MAC Service Data Unit Aggregation (A-MSDU) and MAC Protocol Data Unit Aggregation (A-MPDU) (Wang and Wei, 2009; Kim *et al*., 2012; Hajlaoui and Jabri, 2012).

Both the above-mentioned frame aggregation schemes have their own strengths and limitations. Due to lesser overheads, A-MSDU performs better in unsaturated traffic. However as traffic increases, A-MSDU performance degrades due to absence of individual frame check sequence number (Wang and Wei, 2009). A-MPDU performs better than A-MSDU due to the presence of individual frame check sequence number. A-MPDU can aggregate frames up to 64 kb size (Saif *et al*., 2012). To support frame aggregation, block acknowledgment feature is also introduced in 802.11n WLAN standard.

The main objective of frame aggregation is to increase the data throughput. For the multimedia applications, time restrains is of major concern. During the aggregation process of video frames, the time required to aggregate frame increases the delay. The delay arises during the aggregation process deviates from the desired video quality.

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In un-saturated traffic, aggregation schemes perform well for the multimedia applications. However, in saturated traffic, aggregation process degrades the performance due to more chances of collisions and waiting period in MAC queues. The number of frames to be aggregated in a single A-MPDU is static in nature and it does not change according to the wireless network environments.

Various researches have reported their analysis on frame aggregation scheme. Camps-Mur *et al*. (2012) and Hajlaoui *et al*. (2012) comments that as traffic increases overall data transmission delay increases and network performance degrades. Moreover, as delay increases time bounded video application's quality gets affected. In the saturated traffic, aggregation of less number of frames is more suitable (Barreira and Ascenso, 2012).

In order to facilitate better video quality, we propose Time Restraint Tractable Aggregation Scheme (TRTAS) methodology. In the proposed aggregation scheme, the numbers of frames to be aggregated depends on the delay threshold of video frames and network traffic congestion. The methodology has been simulated and validated using NS2 simulator.

IEEE 802.11n MAC agregation: The IEEE 802.11n WLAN standard is developed to provide the higher data throughput. The higher throughput is achieved by various MAC enhancements. Much of the enhancement works are done to reduce the overheads. As the MAC overheads are essential, the emphasis is for reducing the frequency of overheads. Reducing of overheads is achieved by appending the frames with common overhead to that group of frames.

By aggregating the frames, the percentage of overheads in aggregated frame gets reduced with respect to the data payload. Thus, the frame aggregation achieves higher throughput with respect to legacy WLAN standards. IEEE 802.11n standard supports two types of frame aggregation schemes as mentioned:

- MAC Service Data Unit Aggregation (A-MSDU)
- MAC Protocol Data Unit Aggregation (A-MPDU)

MAC Service Data Unit Aggregation (A-MSDU): Multiple MAC Service Data Units (MSDUs) are aggregate to form a single one A-MSDU. Only those MSDU can be concatenated which are having the same source and same receiver address. The frames passed down by Link Layer are buffered in the access categories and then aggregated to construct a single A-MSDU. In an A-MSDU, every MSDU frame has sub-frame header, data units and padding bytes (Saif *et al*., 2012; Maqhat *et al*., 2012). The structure of an A-MSDU is shown in Fig. 1.

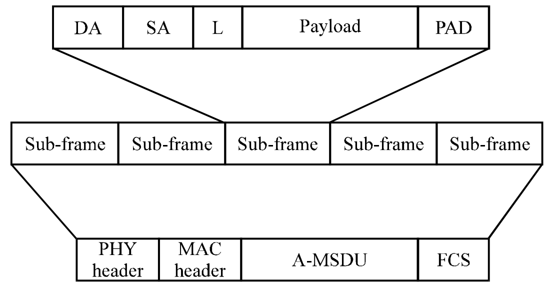

Fig. 1: A-MSDU aggregation

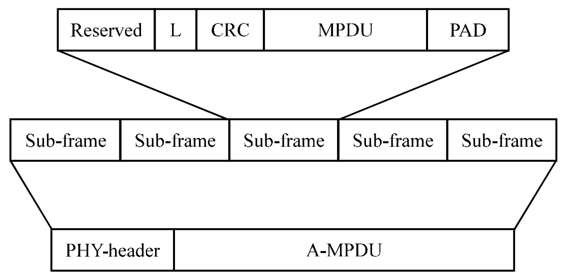

Fig. 2: A-MPDU aggregation

The sub-frame is consisting of destination address, the source address and length of sub-frame, data and payload. In A-MSDU, there is no frame checksum for an individual sub-frame. Therefore, during retransmission, selective corrupted MSDU cannot be re-transmitted. In spite whole A-MSDU has to be re-transmitted. After aggregating frames, MAC header is added in front and frame check sequence is appended to form a PSDU. The maximum length of an A-MSDU can be of 7935 bytes (Skordoulis *et al*., 2008).

MAC Protocol Data Unit Aggregation (A-MPDU): The MPDUs passed down by logical link layer are encapsulated with MPDU delimiter and the padding bytes. Then multiple MPDUs are aggregated to form an A-MPDU with a PHY header. The structure of A-MPDU is shown in Fig. 2. Only those MPDU frames are aggregated which are having same destination address (Bellalta *et al*., 2016). The MPDU frame consists of delimiters, CRC bits, length of MPDU and padding bits. Every MPDU in aggregated frame has its own CRC field. Thus during retransmission, selective corrupted MPDU can be re-transmit which saves the time and optimizes the network resources. The maximum length of A-MPDU can be 65535 bytes (Charfi *et al*., 2013).

The aggregation schemes are having their own advantages and disadvantages. Aggregating frames in a single frame will increase data throughput but the delay

Table 1: Limitation of standard frame aggregation

Methodology	Researchers	Limitations
Standard frame aggregation	Wang and Wei (2009), Saif *et al.* (2012)	A-MPDU aggregation performs better than A-MSDU aggregation scheme
	Selvam and Srikanth (2010) and Skordoulis *et al.* (2008)	As network traffic congestions increases frame aggregation process increases delay during data transmission
	Kuppa and Dattatreya (2006), Kolap *et al.* (2012)	Smaller A-MPDU size is preferable in congested network
	Lee *et al.* (2008) and Hajlaoui *et al.* (2012)	Frame aggregation process raises the delay during the video transmission that degrades the QoS

may arise due to the time required for aggregation process. If during the transmission due to noisy environment or any collisions the frame is not received by receiver station then all frames are to be re-aggregated and re-transmitted. The re-transmission of frames causes more delays.

For the real time application such as voice or video transmission, delay is a major constraint. Hence, as the traffic load increases chances of collision increase this in turn leads to more re-transmissions. In the case of video transmission, if the receiver station's video decoder waits for a time to receive the consecutive video frames, then the video quality will degrades. Even if the decoder misses the preceding video frame from the video sequence, video quality degrades.

For example, in generic terms, a preceding video frame must be processed within 500 msec at the receiver station. If the video frame is not processed within this time, a video gap comes between the video sequences. This frame gap degrades the video quality. Thus, a delay or jitter arises in the decoded video.

In Table 1, we summarize the literature survey on the limitations of standard frame aggregation utilization for video transmission over IEEE802.11n.

We proposed time restraint tractable aggregation scheme for video transmission over WLAN. In the proposed methodology, based on video frame's delay threshold and network congestion, less number of frames are aggregated to reduce the end-to-end delay, jitter and gain the PSNR.

MATERIALS AND METHODS

The IEEE 802.11n frame aggregation scheme is a very effective process for achieving higher data throughput in a wireless network. While aggregation of the frames in the applications likes video transmission, large numbers of frames are concatenate to form a single frame. However, during the aggregating the frames, the delay arises due to the aggregation process.

Each video frame in an aggregated frame has a delay threshold limit, before which that frame must be received and processed at the destination station. The delay threshold of the frames are decided by the video codec standards. While receiving the frames at destination, frame has to be received within that delay threshold. If the frame is received after delay threshold, it is of no use and that frame is discarded. If the successor frame received before the predecessor frame then also the frame is of no use and that successor frame will be discard.

Every video frames passes through three time slots for successful transmission between source and receiver station. The above three time slots are: the time required for processing of a frame at sender station, transmission time and processing time at receiver station. For the better video quality, each upcoming predecessor video frame at the receiver should be processed within 500 msec. Therefore, overall time of a video frame to travel from source to destination station must be completed within 500 msec. So, here by the total time required for: processing the video frame at source, frame transmission time and destination processing time must be completed within deadline time.

Due to the increasing traffic congestions, we should reserve maximum time slot for the transmission process of the video frames. Therefore, we believe that the processing of video frames at the sender station should be completed within 200 msec. In our study, we focus on the time required for the processing of A-MPDU at the source station and consider the video frame delay threshold for processing of A-MPDU equals to be 200 msec. For the betterment of video quality, an A-MPDU must be transmit by a sender station before the video frame delay threshold crosses the limit.

The proposes methodology estimates the deadline time until which the frames can be aggregate. The deadline time is estimated with respect to the expiry time of first few frames in that A-MPDU. Further, concurrently the video queue is analyzed to find the optimal number of frames that can be aggregated in a single A-MPDU. Finding the optimal frame numbers is achieved by analyzing the network traffic congestion. The proposed TRTAS scheme is presented in Algorithm 1.

Algorithm 1 (TRTAS):
Requires:
T_{FFET}: First video frame expiry time
$AC[VI]_{MBL}$: Maximum buffer limit of video queue
$AC[VI]_{BOP}$: Video Buffers occupied at an instance
$AC[VI]_{MQIR}$: MAC queue injection rate of video access category
$AC[VI]_{MQER}$: MAC queue ejection rate of video access category
$AC[VI]_{TLD}$: Traffic flow difference in video queue
$AC[VI]_{CF}$: Buffer augmentation factor at video queue
$AC[VI]_{TC}$: Traffic congestion at video queue
A_{NADT}: New aggregation deadline time
F_{ML}: Maximum frame limit
F_{ONF}: New optimal frame numbers to be aggregated
A_T: Aggregation Timer value in seconds
F_{EFA}: Number of existing frames in A-MPDU

Procedure (Aggregation_Deadline_Estimation()):
Determine the first video frame expiry time (T_{FFET})
Get the value of $AC[VI]_{MBL}$
Determine the $AC[VI]_{BOP}$ at that instance
Determination of MAC queue rates
Ascertain the value of $AC[VI]_{MQIR}$ at video queue
Ascertain the value of $AC[VI]_{MQER}$ at video queue
Determine the rate of traffic flow difference at video queue:

$$AC[VI]_{TLD} = AC[VI]_{MQIR} - AC[VI]_{MQER}$$

Determine congestion factor; $AC[VI]_{CF}$:

$$AC[VI]_{CF} = AC[VI]_{TLD} / AC[VI]_{MQIR}$$

Determine traffic congestion at video queue; $AC[VI]_{TC}$:

$$AC[VI]_{TC} = AC[VI]_{BOP} * AC[VI]_{CF}$$

Determine new aggregation deadline time: A_{NADT}:

$$A_{NADT} = T_{FFET} - AC[VI]_{TC}$$

Determine the maximum frame limit: F_{ML}
Determine the new optimal numbers of frames to be aggregate:

$$F_{ONF} = F_{ML} - AC[VI]_{TC}$$

Append the frame in A-MPDU and call procedure Frame_Aggregation()
End procedure

Procedure (Frame_Aggregation()):
```
    if (A-MPDU is Empty)
            Call: Aggregation_Deadline_Estimation();
    else
            Determine Aggregation Timer (A_T)
               Determine number of existing frames in A-MPDU (F_EFA)
            if (A_T<A_NADT&&F_EFA<F_ONF)
               Append the frame
            else
                  Append the frame and Construct an A-MPDU.
                 Pass A-MPDU to lower PHY Layer
                Empty A-MPDU Buffers
            end if
    end if
End procedure
```

The proposed TRTAS scheme is present in the form of flowchart show in Fig. 3.

Experimental SET-UP: The evaluation of the video transmission over WLAN is simulated in Network Simulator (NS2). The NS2 is characterized by myEvalSVC (Ke, 2012; Lai and Liou, 2013) and Joint Scalable Video Model (JSVM) video traces (Rhaiem and Fourati, 2015; Singh *et al*., 2013). JSVM is an open source tool used for encoding and decoding of H.264/SVC video codecs. The myEvalSVC evaluation tool is collaborated with NS2 to support H.264/SVC video codec transmission over wireless network (Patel and Choudhary, 2007).

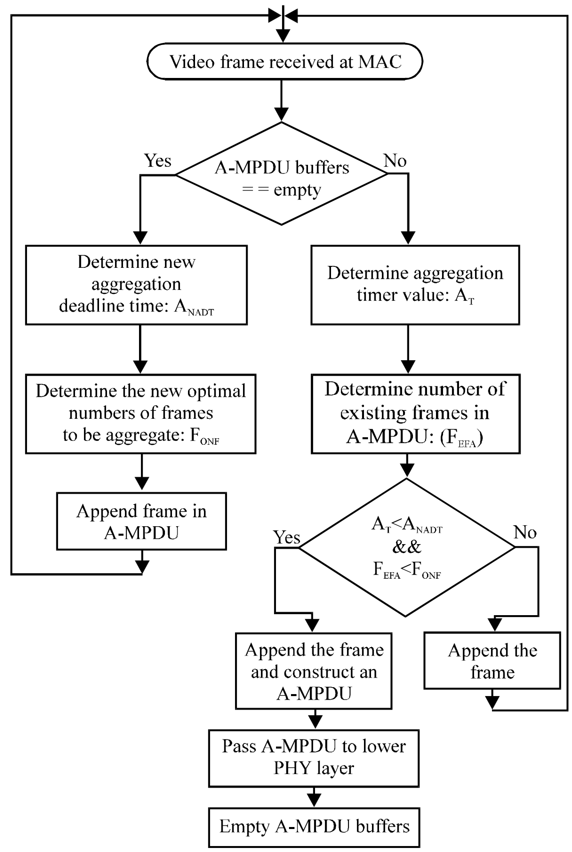

Fig. 3: Flowchart of proposed TRTAS scheme

The NS2 set up for the evaluation of video over WLAN is shown in Fig. 4. The H.264/SVC video clip is firstly encoded in the video trace file that is supported by NS2. This encoding is done with the help of JSVM. The trace file generated is then pass to NS2 environment. Here an access point transmits the encoded video to the receiver station. After the simulation ends, a sender trace file and a receiver trace file is generated. Various performance metrics such as delay, jitter and losses of different video slices are determined at this point by comparing sender trace file and a receiver trace file.

The topology for the simulation scenario of TRTAS consists of an access point and IEEE 802.11n receiver station. For simulating TRTAS methodology numerous

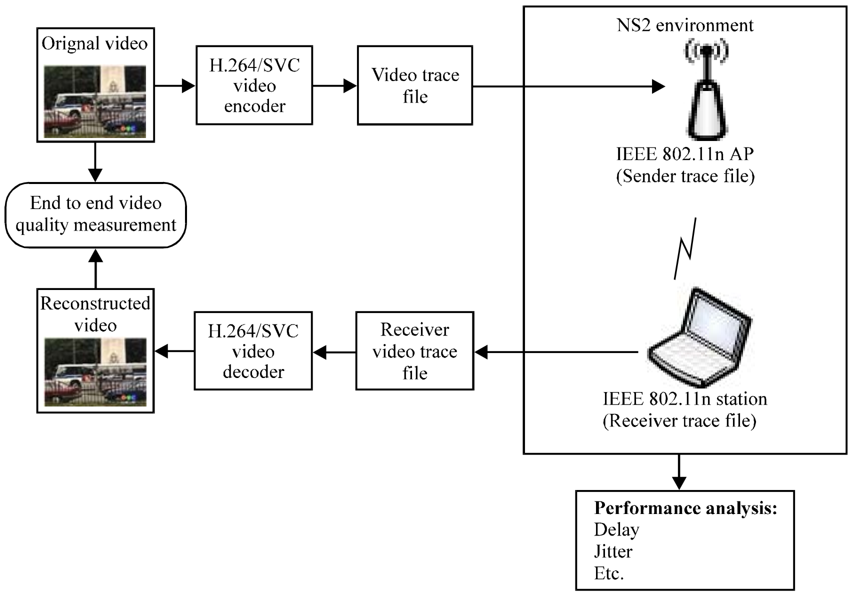

Fig. 4: Experimental setup for evaluation of video transmission over WLAN

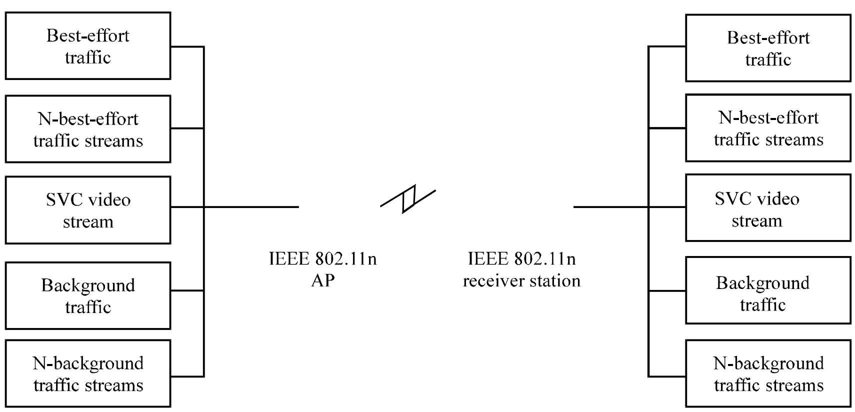

Fig. 5: Scenario specification for TRTAS methodology

best-effort and background traffic is transmitted along with video streams form sender to receiver station. In TRTAS, numbers of video streams are adaptable according to the desired network congestions. The characteristic of the network flows for TRTAS is shown in Fig. 5.

RESULTS AND DISCUSSION

For distinction the network load, we classify the network traffic in generic terms as below: no network congestion, moderate network congestion and heavy network congestion. The suggested network congestions scenarios are mainly classified by measuring the video traffic. The network handling only one video stream is considered as having no traffic congestion or having minimum network traffic load. Transmitting of two or three video streams concurrently over the network is classified as moderate network congestion or intermediate traffic load that is in permissible limit. Transmitting more than three video streams concurrently are classified as heavy network congestion or the network load that is not suitable for the better video QoS.

After extensive simulation of proposed TRTAS methodology over experimental setup, the results of performances metrics such as end-to-end delay, jitter and PSNR are present below. In Fig. 6-12 presented, the average values obtained at MQER with 500, 750 kbps

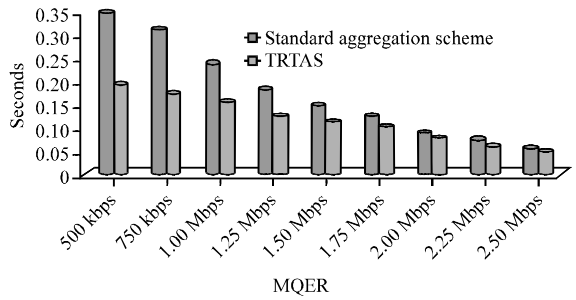

Fig. 6: Comparison of end-to-end delay of standard frame aggregation and TRTAS methodology at no, intermediate and heavy network congestion

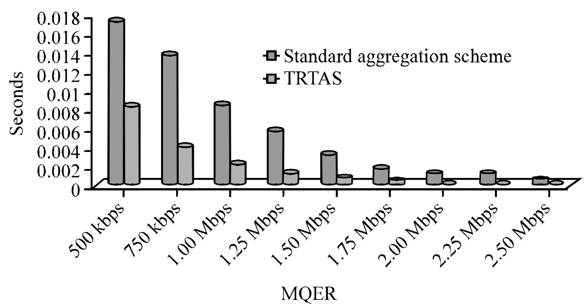

Fig. 7: Comparison of jitter of standard frame aggregation and TRTAS methodology at no, intermediate and heavy network congestion

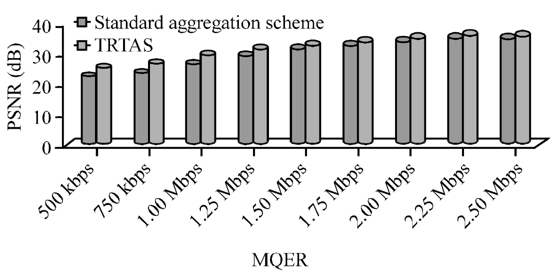

Fig. 8: Comparison of PSNR of standard frame aggregation and TRTAS methodology at no, intermediate and heavy network congestion

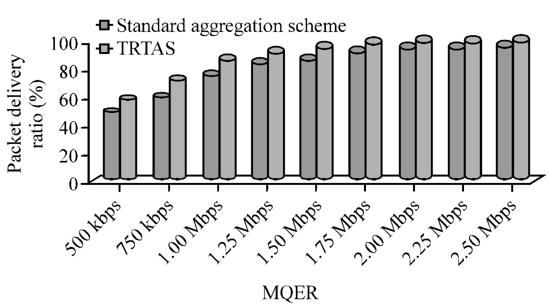

Fig. 9: Comparison of packet delivery ratio of standard frame aggregation and TRTAS methodology at no, intermediate and heavy network congestion

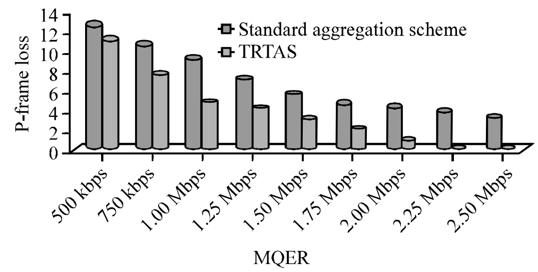

Fig. 10: Comparison of P-frame loss in standard frame aggregation and TRTAS methodology at no, intermediate and heavy network congestion

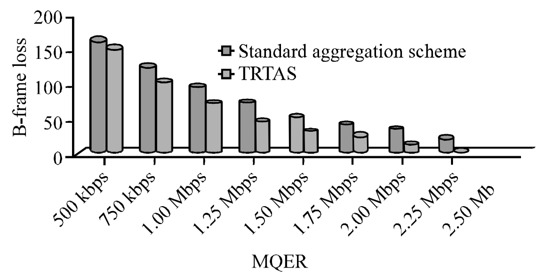

Fig. 11: Comparison of B-frame loss in standard frame aggregation and TRTAS methodology at no, intermediate and heavy network congestion

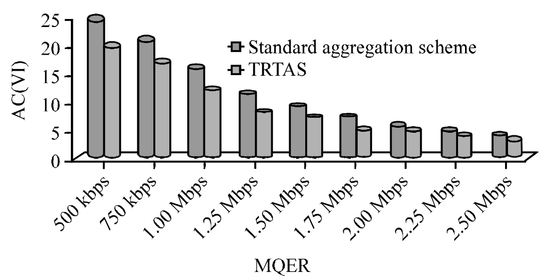

Fig. 12: Comparison of video queue utilization in standard frame aggregation and TRTAS methodology at no, intermediate and heavy network congestion

and 1.0 Mbps is consider for heavy network congestion. The average values obtained at MQER with 1.25, 1.50 and 1.75 Mbps is considered for intermediate network congestion. In addition, the average values of MQER with 2.00, 2.25 and 2.50 Mbps is considered for no network congestion.

Figure 6 shows the comparison of end-to-end delay in standard frame aggregation process and TRTAS methodology at no, intermediate and heavy network congestion. The proposed TRTAS methodology shows a better result than standard frame aggregation scheme. Better performance of TRTAS is due to taking the consideration of aggregated first video frame's maximum delay limit and current video queue traffic congestions for aggregating a single A-MPDU. Thus, in the proposed TRTAS methodology scheduler aggregates a lesser number of video frames then standard scheme. The aggregation of lesser frames reduces the waiting time in the video queue that results in a lower end-to-end delay. In high traffic congestion, the proposed methodology considerably performs better than standard frame aggregation methodology where TRTAS reduce end-to-end delay on average of 41.57% in comparison with standard frame aggregation methodology.

As TRTAS aggregates lesser video frames, TRTAS performs better in intermediate traffic congestion and no network congestions scenario. In intermediate traffic congestion, TRTAS methodology reduces end-to-end delay on average of 24.1% in comparison with standard frame aggregation methodology. In no traffic congestion, TRTAS methodology also reduces end-to-end delay on average of 16.66% in comparison with standard frame aggregation methodology.

Figure 7 shows the comparison of jitter in standard frame aggregation process and TRTAS methodology at no, intermediate and heavy network congestion. TRTAS aggregates video frames based on time constraints, therefore, maximum A-MPDU size adjusts accordingly to maximum delay constraints and video queue congestions. Due to above time constraints the waiting time of video frame in AC[VI] is reduced. Lowering down waiting time reduces the probability of re-transmission of aborted video frames that are caused by exceeding the waiting time than the maximum permissible time limit (T_{FFET}).

Thus, the overall advantage of the proposed methodology provides fluent transmission of video frames. TRTAS methodology gives better jitter results in high traffic congestion, moderate congestion and in no network congestion. Lower the jitter value more smoothen the received video quality. In high traffic congestion, the proposed TRTAS methodology considerably performs better than standard frame aggregation methodology where TRTAS reduce jitter on average of 77.5% in comparison with standard frame aggregation methodology. The same trend is seen in intermediate traffic and no traffic congestion where TRTAS reduce jitter on average of 75.76 and 66.3%, respectively. Thus, the proposed TRTAS methodology reduces jitter in all the traffic load scenarios.

Figure 8 shows the comparison of PSNR in standard frame aggregation process and TRTAS methodology at no, intermediate and heavy network congestion. In high traffic congestion, TRTAS methodology increase PSNR on average by 11.34% in comparison with standard frame aggregation methodology. In intermediate network congestion, TRTAS performs better than standard aggregation scheme. The percentage increment of PSNR value is 10.68% in intermediate network congestion.

In no traffic congestion, the proposed TRTAS methodology increase PSNR on average by 6.23% in comparison with standard frame aggregation methodology. Hence, the PSNR value has been gained in all the traffic congestions.

Figure 9 shows the comparison of packet delivery ratio in standard frame aggregation process and TRTAS methodology at no, intermediate and heavy network congestion. As TRTAS methodologies emphasis on video frame's maximum delay constraints and current video queue traffic load, the numbers of aggregated frames in a single A-MPDU are lesser. The constructed A-MPDU is transmitted before their video frame crosses the maximum delay (A_{NADT}). Thus, due to earlier frame transmission, the chance of retransmission of video frame is reduced and the proposed TRTAS methodology gives better packet delivery ratio than standard frame aggregation scheme. As shown in Fig. 9, packet delivery ratio of TRTAS is better than standard aggregation scheme at all the network congestions. TRTAS methodology increase packet delivery ratio on average by 14.1, 10.97 and 9.89% in high traffic, intermediate traffic and no traffic congestion, respectively in comparison with standard frame aggregation methodology.

Figure 10 and 11 show the comparison of P-frame and B-frame losses, respectively in standard frame aggregation process and TRTAS methodology at no, Intermediate and heavy network congestion. As traffic congestion increases, methodology transmits the A-MPDU before the reaching the delay threshold which in turn saves the MPDUs in an aggregated frame. In addition, due to less waiting time in video access category the proposed methodology save the video frames from dropping out of video queue.

In higher traffic congestion, TRTAS saves on average of 29.17% of P-frames in comparison with standard frame aggregation scheme. Thus, TRTAS helps in providing better QoS at receiver side even in high traffic congestion. In intermediate traffic congestion, TRTAS saves on average of 41.3% of P-frames in comparison with standard frame aggregation scheme. In no network traffic congestion, even there is no traffic load but as the aggregation process is completed before delay threshold value of first frame, the proposed TRTAS methodology saves all the P-frames.

Figure 12 shows the comparison of video queue utilization in standard frame aggregation process and TRTAS methodology at no, intermediate and heavy network congestion. Network traffic congestion is measured by estimating the occupancy of the buffers at video access category. TRTAS methodology optimally constructs A-MPDU and transmits them. Due to the time restraint tractable nature of the proposed methodology, the occupancy of video buffers is lesser then standard frame aggregation.

It can be seen in Fig. 12 that, average occupancy of video queue buffers by TRTAS is lesser than standard frame aggregation methodology in all the network congestions. Video queue utilization is reduced on an average by 32.06, 30.55 and 27.28% in high traffic, intermediate traffic and no traffic congestion, respectively in comparison with standard frame aggregation methodology.

Compendious of obtained results: The metrics for analyzing the video quality such as end-to-end delay, jitter and PSNR are been improved by the proposed TRTAS methodology. From the results obtained, it has been observed that proposed TRTAS methodology reduces the end-to-end delay, jitter and gains the PSNR value in comparison with the standard frame aggregation methodology. The results obtained for the performance metrics such as packet delivery ratio, saving of ‘P and B frames’ and video queue utilization also counter supports that TRTAS methodology performs better in providing the more beneficial video quality. During the no traffic congestion, the average waiting time of video frames in AC[VI] is reduced which in turn gives the better performance. Also, in high traffic load scenario, TRTAS methodology performs considerably better due to the transmission of smaller A-MPDUs. From the obtained experimental results, it can be concluded that TRTAS methodology performs better than standard frame aggregation process in all type of network congestions ranges from no network traffic congestion to higher network traffic congestions. Thus, TRTAS methodology can be used for the video transmission over WLAN.

Figure 13 shows the snapshots of decoded video frames of “Bus.cif” at the reciver station using the

Fig. 13: Comparison of decoded video frame in standard frame aggregation scheme and TRTAS methodology: a) Original Video; b) Decoded video frame in standard frame aggregation scheme and c) Decoded video frame in TRTAS methodology

Table 2: Summarize gain/loss of proposed TRTAS methodology in comparison with standard frame aggregation scheme

Methodology	Performance metric	High traffic congestion (%)	Intermediate traffic congestion (%)	Low traffic congestion (%)
Standard frame aggregation	End-to-end delay (reduced)	41.57	24.10	16.66
	Jitter (reduced)	77.50	75.76	66.33
	PSNR (increased)	11.34	10.68	6.23

standard frame aggregation methodology and proposed TRTAS methodology. The snapshots exemplifies that proposed TRTAS methodology (Fig. 13c) provides better video display than the standard aggregation methodology (Fig. 13b).

The results obtained through experimental evaluation for measuring QoS performance metrics is summarized below in form of table presented in Table 2. Summarization is presented in form of total percentage gain with respect to standard frame aggregation in less network, moderate network and high network congestions. From the obtained experimental results, it can be concluded that TRTAS methodology performs substantially better in all the network traffic congestions.

CONCLUSION

In this study, we proposed time restraint tractable aggregation methodology for better video transmission over WLAN. In TRTAS methodology, aggregation process is completed based on the time constraint. By considering the time constraint in aggregation process, delay is reduced during the aggregation process. The TRTAS methodology dynamically adjusts frame length according to the time, i.e., A-MPDU is aggregate in the dynamically calculated aggregation deadline time. The TRTAS methodology also senses the network traffic congestion by measuring the video queue and decides the optimal number of frames that can be aggregate. By reducing the number of frames in A-MPDU, aggregation process reduces the waiting time of frames in video queue. After exhaustive experimentations with the proposed methodology over NS2 simulator, the experimental results clearly shows that, proposed TRTAS methodology performs better than the standard Frame aggregation process. The proposed methodology is able to reduce the average end-to-end delay and jitter as compared to standard frame aggregation process. The PSNR value of received video in our proposed methodology is also increased. Thus, TRTAS methodology is best suitable for time-bounded video applications such as video conferencing applications.

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