IMPROVE PERFORMANCE OF SATURATED WLAN DURING REMOTE PATIENT MONITORING

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Abstract

WLAN plays important role in remote patient monitoring, it represents the intermediate component between the WPAN and the backbone of WSN ,In this paper we introduced a proposed switch-case algorithm to improve the performance of the WLAN by decreasing the delay and increasing the throughput for any degradation especially if there is a huge degradation that can be caused by dense patient monitoring, this algorithm has five improved mechanisms include enhanced techniques of 802.11n such as block acknowledgment, Channel bonding, frame aggregation and spatial multiplexing. This algorithm is equipped to both non-jamming and jamming environments.

Keywords: *WLAN, 802.11n, Dense Monitoring, Acknowledgment, Channel Bonding, Aggregation And Spatial Multiplexing*

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1. INTRODUCTION

Wireless Local Area Network (WLAN) is considered one of the research areas in computer science and the E-health applications especially in Wireless sensor network (WSN) for improving the quality of healthcare.WSN have been widespread and effective in the most of E-health monitoring systems [1]. Patients can carry wearable sensors that can detect vital signs (*such as*, glucose level, heart rate, *etc.*) and can monitor the patient continuously using short-range wireless communication such as wireless personal area network (WPAN)[2]. After that a personal gateway node collects all the sensor data from the WPAN and forwards them to a doctor or a remote online server in the hospital. The connection of the gateway to the backbone of WSN is generally based on middle-range wireless communication such as WLANs and based on long-range wireless communication such as WiMAX. WLANs represent the best choice for remote patient monitoring and produce much more of benefits to the hospitals, including monitoring unlimited number of patients, significant cost savings, and enhanced patient mobility [3].But there are some possible long delays that can be occur as a result of saturation of the health hotspot due to more increased of health data traffic used by patients, doctors and hospitals. Long delay may negatively affect on the patient monitoring operation. So we have introduced a proposed switch–case algorithm to solve this problem using a proposed improved mechanisms to enhance the WLAN performance by increasing the throughput with short delay. Recently 802.11n expressed as the best and most standard of WLAN that is applied by many health hotspots in remote E-health monitoring.

2. LITERATURE REVIEW

Many researchers have worked on evaluation of WLAN performance. For example a study was performed by Manoj Tolanion and Rajan Mishra on Effect of Increasing Load on WLAN using different routing protocols and check performance of which routing protocol not degraded on increasing load means which routing protocol is less sensitive to load [4].another study was performed by Rajan Vohra, Ravinder Singh Sawhney and Gurpreet Singh Sainion enhancing WLAN performance by tuning different metrics such as buffer size fragmentation threshold and request to send (RTS) thresholds, By varying the buffer size to a value other than specified in the standards, will reduce WLAN delay, media access delay with minutest changes observed in throughput [5]. Mudathir Babiker analyzed different WLAN standards was concerned and the IEEE 802.11 standards have been studied and compared regarding their Voice over Wi-Fi performance based on Throughput, Delay [6]. Meenakshi and Parneek Kaur concentrate on their efforts to find out metrics namely network delay and throughput by varying numbers of user and data traffic [7]. Amel Aboud published a paper contains a comparison of some of the WIFI 802.11 standards [8]. Zainab T. Alisathe introduced a proposed system in which End to end delay, media access delay, throughput, load, traffic received and traffic sent is evaluated for the physical layer technologies IR, DSSS, FHSS and OFDM at multiple transmission rates [9]. But no one introduce a suitable algorithm including improved mechanisms to overcome the saturated problem in case of the traffic transfers for saturated WLAN hotspot. Our proposed improved mechanisms of WLAN performance introduce multiple solutions based on the levels of degradation in saturated WLAN.

3. IEEE 802.11N

IEEE 802.11 is a set of standards for wireless local area network (WLAN), developed by the IEEE LAN/MAN Standards Committee (IEEE 802) in the 5 GHz and 2.4 GHz public spectrum bands. Both terms 802.11 and Wi-Fi are often used. The 802.11 standard includes over-the-air modulation techniques that use the same basic protocol. The most popular are those defined by the 802.11b and 802.11g protocols, and are amendments to the original standard. Some of the important protocols are IEEE 802.11n is a proposed amendment to the IEEE 802.11-2007 wireless networking standard to significantly improve network throughput over previous standards, such as 802.11b and 802.11g, with a significant increase in raw (PHY) data rate from 54 Mb/s to a maximum of 600 Mb/s. It is also known as draft-n. The 802.11n standard will offer several advantages over previous wireless LAN technologies. The most majorable advantages are substantially improved efficiency and greater application data throughput [10].

4. MAC LAYEROVERHEADREDUCTION

The PHY enhancements described thus far increase maximum PHY data rate, but would make very inefficient use of the airwaves without the following MAC layer enhancements also utilized by 802.11n.

4.1 Block Acknowledgement

It reduces the number of ACKs that a receiver must send to a transmitter to confirm frame delivery. Legacy 802.11a/g transmitters expect an (almost immediate) ACK for each non-multicast/broadcast frame. But 802.11n transmitters also accept Block ACKs which confirm receipt of multiple unicast frames. For example, instead of sending 9 legacy ACKs to confirm frames 1 through 8 and 10, an 802.11n receiver can say the same thing with just one Block ACK [10].

4.2 Channel Bonding

Legacy WLANs operate over 20-MHz channels, but 802.11n can operate over 20-MHz or 40-MHz channels. This is a feature that is configurable when deploying 802.11n WLANs. 802.11n uses channel bonding to join two 20-MHz channels into one that is 40-MHz wide, which provide much higher data rates. Channel bonding is best if done in the 5-GHz band only because the 2.4 GHz band does not have enough room for effective frequency reuse [11].

4.3 Frame Aggregation

One of the most important features in the draft-n specification is frame aggregation to improve mixed mode performance. Rather than sending a single data frame, the transmitting end user bundles several frames together. Thus, aggregation improves efficiency by restoring the percentage of time that data is being transmitted over the network. The two different types of 802.11n aggregation are defined:

1. Aggregation of MAC Service Data Units (MSDUs) at the top of the MAC (referred to as MSDU aggregation or A-MSDU)
2. Aggregation of MAC Protocol Data Units (MPDUs) at the bottom of the MAC (referred to as MPDU aggregation or A-MPDU) [10].

4.4 MSDU Aggregation

MSDU aggregation bundles multiple Ethernet frames (each is a separate MSDU) requiring transmission over the WLAN and wraps them into a single frame, which contains a header and cyclic redundancy check (CRC) field. This produces an 802.11 MPDU as shown in Figure 1. MSDU aggregation is the most efficient because Ethernet headers are relatively short (as compared to 802.11 headers). The receiving station acknowledges the entire aggregated frame with a single 802.11 Block ACK frame. A common method encrypts the entire frame body (all MSDUs) the same [11].

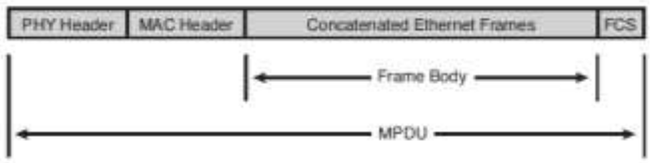

Fig -1: A-MSDU

4.5 MPDU Aggregation

MPDU aggregation works at the bottom of the 802.11 MAC layer by collecting and wrapping multiple MPDUs (minus the FCS field) into a single 802.11 frame, as shown in Figure 2. The efficiency of MPDU aggregation is not as a good as MSDU aggregation because of the larger individual 802.11 frame headers (as compared to Ethernet), and encryption is done for each individual MPDU frame contained within the frame body. MPDU aggregation requires that all constituent frames be acknowledged; however, it uses a block ACK, which compiles all ACKs into single frame called block acknowledgment. After receiving the block ACK frame, the sending station can selectively retransmit only the data frames that did not include an acknowledgment [11].

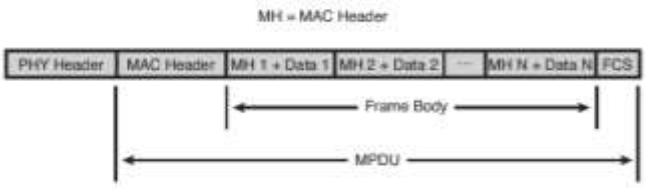

Fig -2: A-MPDU

4.6 Spatial Multiplexing

To dramatically improve throughput, 802.11n MIMO implements spatial multiplexing, which allows separate data streams (referred to as spatial streams) to be set between the sending and receiving stations. 802.11n specifies a maximum of four transmitters at the sending station and four receivers at the receiving station (4x4 configuration) as shown in Figure 3, which offers maximum throughput [11].

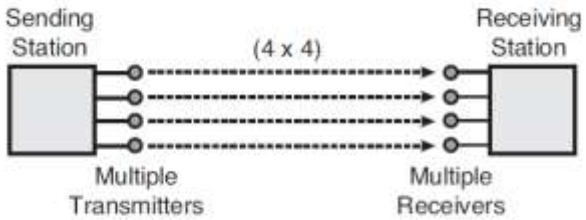

Fig -3: 4x4 spatial multiplexing

5. OUR PROPOSED AGLORITHM

In this paper we have introduced a proposed algorithm using switch-case statement as shown in Figure 4 to solve the non-accepted performance that can be caused by a remote dense patient monitoring, the algorithm is initialized by WLAN parameters and starting mechanism that are simulated by scenario noX in which the density of health WLAN hotspot is set by the number of patients and doctors that are found in the hotspot area. After that patient monitoring is operated, then delay and throughput are produced as results then an evaluation of the WLAN performance is performed, if the performance is degraded to one of the five levels that are sorted in ascending order from -1 to -5 where the least degradation in performance indicated as -1 that can be occurred with low increasing in delay due to a thin saturated monitoring operation and the worst degradation in performance indicated as -5 that can be occurred with very high increasing in delay due to a dense saturated monitoring operation, so there are five improved mechanisms from first improved mechanism to fifth improved mechanism. In the first improved mechanism that is simulated by scenario X1 in which the normal acknowledgment is replaced by a block acknowledgement that reduces a transmission overhead. In the second improved mechanism that is simulated by scenario X2, the block acknowledgment and 40MHz bandwidth are used where significant gain in physical layer data rate is achieved. In the third improved mechanism that is simulated by X3 the techniques of the second improved mechanism are used and additional to A-MSDU with no radio jamming. But with radio jamming the third improved mechanism is not suitable this simulated by scenario X4.In the fourth improved mechanism that is simulated by scenario X5 A-MSDU is replaced by A-MPDU. In the fifth improved mechanism that is simulated by X6, the block acknowledgment,40-MHz, A-MSDU with no radio jamming and additional to a 4×4 spatial multiplexing or MIMO technique are used. Finally if there is a throughput with no degradation in delay, the performance is accepted.

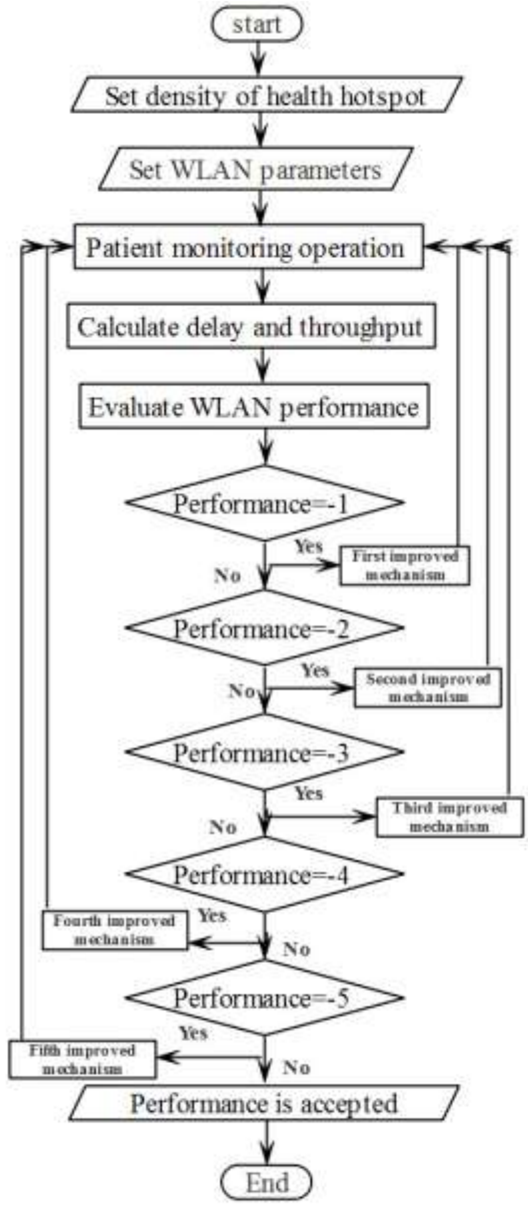

Fig -4: proposed algorithm based on switch case statement

6. SIMULATION AND CONFIGURATION

In order to study the performance of WLAN using our proposed algorithm, the network have been simulated using scenarios of OPNET simulator, so the Performance of the WLAN is evaluated with different scenarios. The infrastructure network also called basic service set (BSS) consists of Access Point (AP) where their stations represent the patients and doctors that want to send their traffic to that AP. This network is configured with hotspot densities 5, 10 and 15 as shown in Fig 5, 6, 7 and 8.All these stations and access point in the network are configured with 802.11n physical layer, 64-QAM is used as modulation technique, band width of 20-MHz,one spatial stream is used at initialization ,the traffic type of service is set to an interactive media ,the packet size is set to 1000-2000 bytes and the normal acknowledgment is set as an immediate acknowledgement.

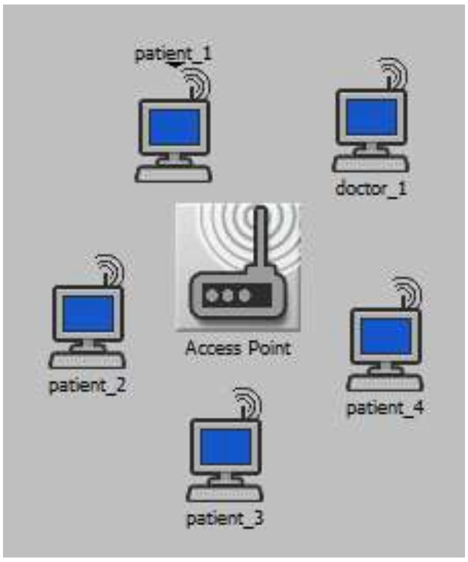

Fig -5: WLAN of 5 density without jamming

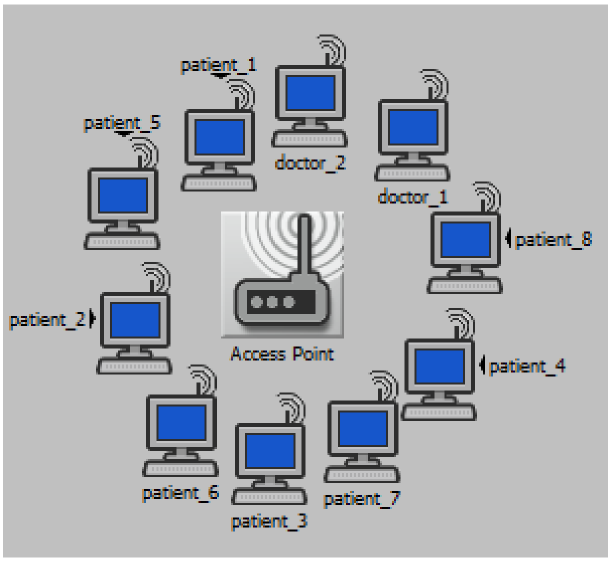

Fig -6: WLAN of 10 density without jamming

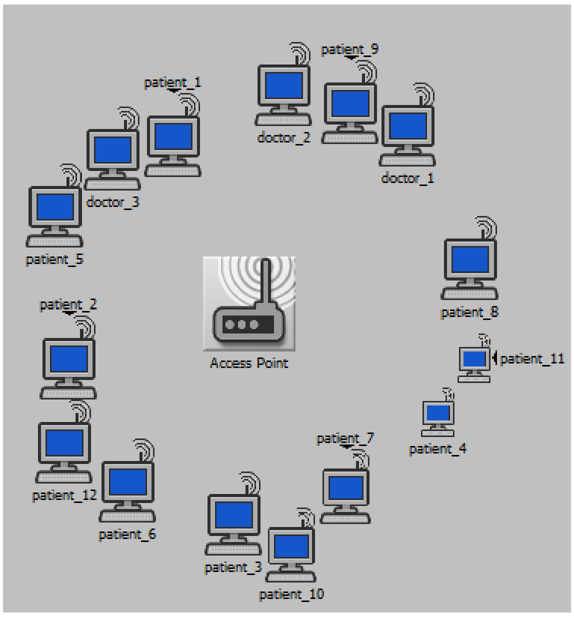

Fig -7: WLAN of 15 density without jamming

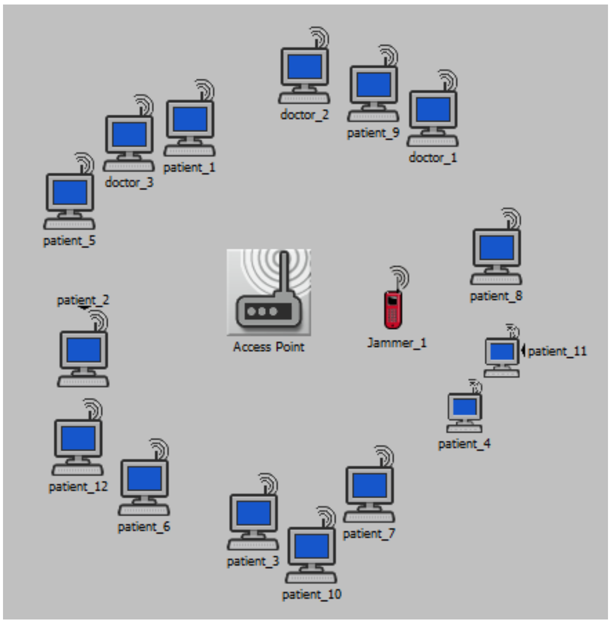

Fig -8: WLAN of 15 density with jamming

7. SCENARIOS

Firstly the algorithm is simulated by seven scenarios named 5_noX, 5_X1, 5_X2, 5_X3, 5_X4, 5_X5 and 5_x6 where 5 represents the hotspot density. Secondly the algorithm is simulated by another seven scenarios with density of 10 named 10_noX, 10_X1, 10_X2, 10_X3, 10_X4, 10_X5 and 10_x6. Finally the algorithm is simulated by seven scenarios with density of 15 named 15_noX, 15_X1, 15_X2, 15_X3, 15_X4, 15_X5 and 15_x6.

8. RESULTS AND ANALYSIS

All the statistics are obtained for delay and throughput results where the delay represents the end to end delay of all the packets received by the wireless LAN MAC of the WLAN node in the network, and throughput represents the total number of bits successfully delivered per unit time. Figure 9,10 and 11 Represent the statistics of the delay result for 5,10 and 15 hotspot density respectively, fig 12,13 and 14 Represent the statistics of the throughput result also for 5,10 and 15 hotspot density respectively, we get the best delay and throughput with the scenario X6 that has the enhanced techniques of scenario X3 plus 4x4 spatial multiplexing technique, so both scenarios X6 and X3 have the best delay and throughput during non-jamming environment. The worst delay and throughput was with scenario X4 where A-MSDU wasn't suitable with jamming environment and scenario noX where there is no any improved mechanism is used, so scenario X5 overcomes the problem in scenario X4 by using A-MPDU that was suitable in jamming environment.

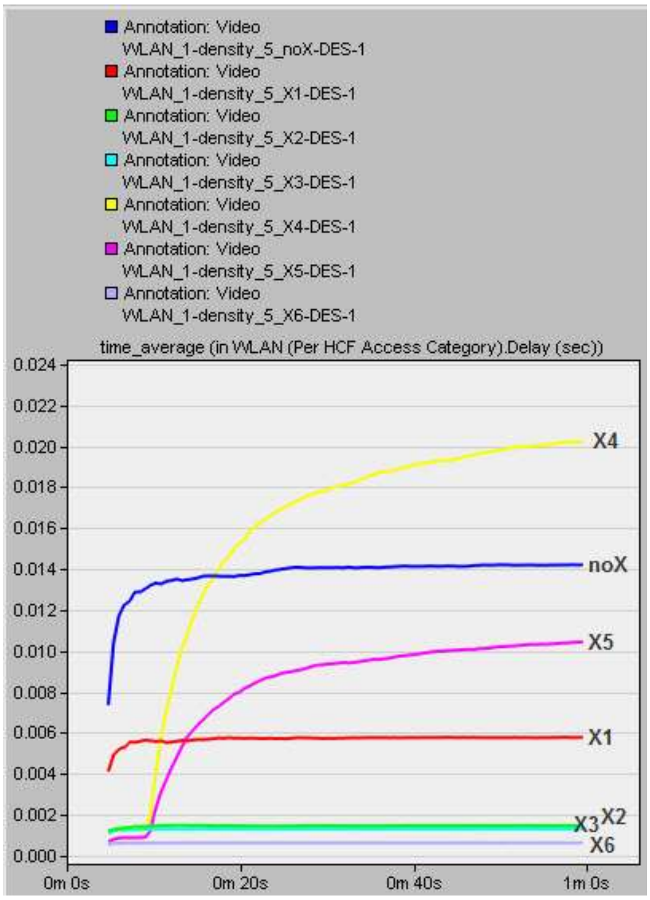

Fig -9: the delay result for 5 hotspot density

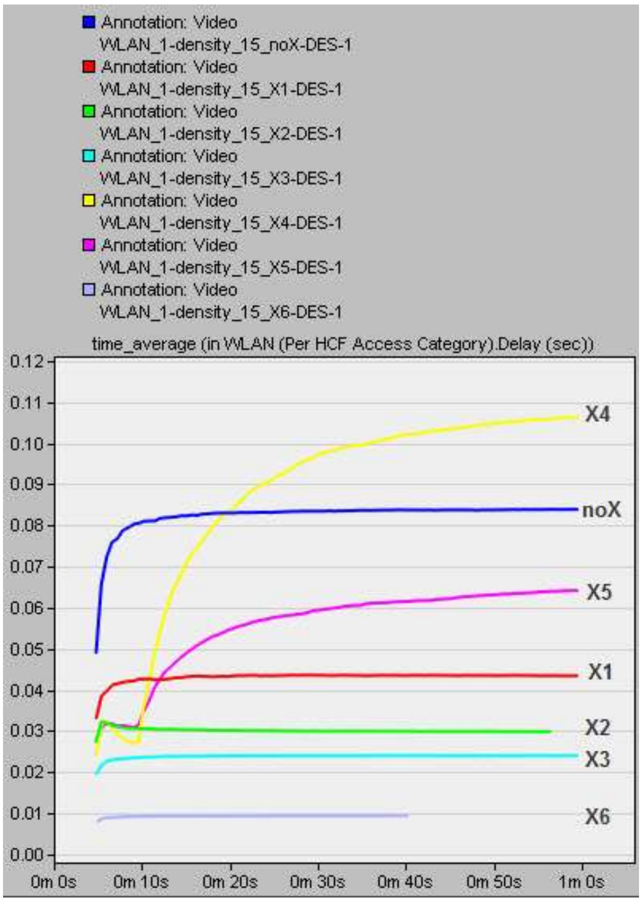

Fig -11: the delay result for 15 hotspot density

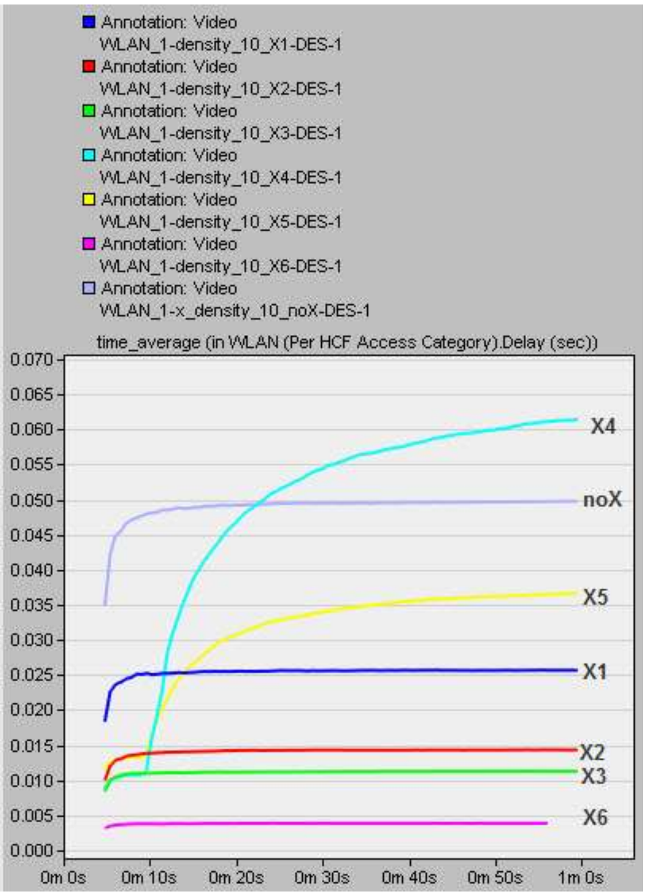

Fig -10: the delay result for 10 hotspot density

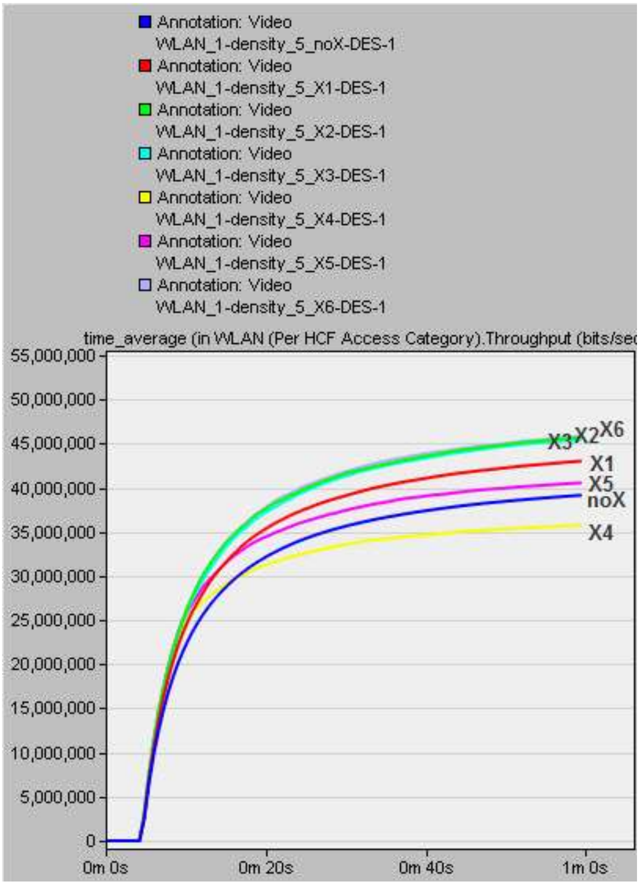

Fig -12: the throughput result for 5 hotspot density

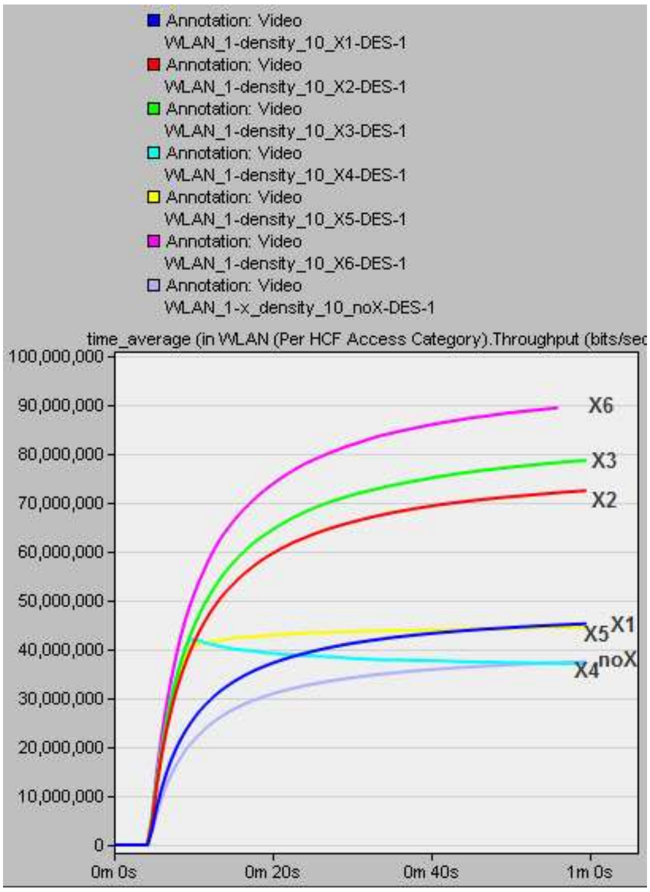

Fig -13: the throughput result for 10 hotspot density

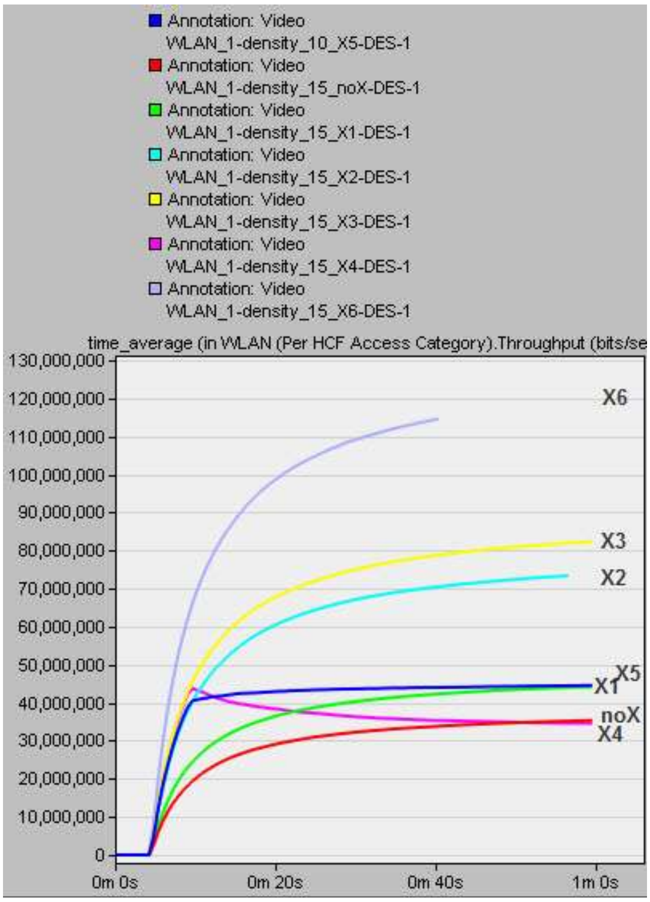

Fig -14: the throughput result for 15 hotspot density

9. CONCLUSION

From the above results and analysis the delay is the highest and the throughput is the lowest with noX scenario where there is no improved mechanism is used and the overhead is high ,and with X4 scenario where individual MSDUs couldn't be recovered when A-MSDU is corrupted mechanism during radio jamming, so all MSDUs are retransmitted. A-MPDU that used in scenario X5 is considered the best solution for jamming problem where the sending station can selectively retransmit only the data frames that did not include an acknowledgment. The delay is the lowest and the throughput is the highest with scenario X6 that used the most efficient aggregation A-MSDU during non-jamming environment plus to the 4x4 spatial multiplexing, so the fifth improved mechanism that used in scenario X6 is considered the best improved mechanism for a huge degradation in saturated WLAN performance that caused by dense patient monitoring process.

The future work can be done in modern WLAN standard such as 802.11ac with their new features that can improve the performance to very high levels.

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