Penerbit Akademia Baru

Journal of Advanced Research in Computing and Applications
ISSN (online): 2462-1927 | Vol. 2, No. 1. Pages 19-24, 2016

Throughput Fairness Using Packet Aggregation on 802.11g Networks

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Abstract – *Throughput fairness in 802.11 environments have been widely studied for most of the researchers. Application protocols with small packet size get lesser throughput compared to large packet size protocols. In this paper, we propose fairness mechanism with selective packet aggregation based on type of protocol. The fairness mechanism affects packets that only belong to delay insensitive protocols. We simulate the mechanism using WLAN simulator and compare the result with standard 802.11g implementation. The simulation result shows, our mechanism can give good equality of throughput and can increase overall system throughput on 802.11g network.*

Keywords: *802.11g, fairness, packet aggregation, wireless network, WLAN*

1.0 INTRODUCTION

Recent development in wireless and mobile technology has been a great impact in shaping our current life. Increased speed and reliability of mobile network help us to connect anytime and anywhere. Wireless LAN (WLAN) technology is growing fast, starting from 1997 with legacy 802.11 protocol with only 2 Mbps data rate to the current 802.11ac protocol that can give us hundreds of M bit data rate per second. Although newer and faster technology have been established, some old and legacy WLAN technology are still widely used, especially in developing countries like Indonesia where there are plenty of mobile devices, laptops and access points use the legacy 802.11b or 802.11g protocols.

WLAN technology allows multiple users share the same communication medium to communicate each other. In order to give the same priority for each node, the legacy 802.11g applies fairness channel access method. Using this method, each node in the wireless network have the same opportunity to transmit its data [1]. However, there are problems with this type of fairness. For instance, the node with the small packet size will get a smaller throughput compared to nodes with larger packet size [2], [3]. This is because, they can send only small packet every time they get the opportunity to send. If every node get the same delivery slot, nodes with smaller packet have less data rates compare to other nodes with bigger packets. Small packet size is used by some protocols, especially control protocol like DHCP. Real time protocols like VOIP also use small packet size in delivering its services [3], [4].

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2.0 PREVIOUS WORKS AND PRELIMINARY SIMULATION

Research on 802.11 throughput fairness have been studied by researchers [1], [5], [6]. In [1], Kim propose fairness mechanism in 802.11n with adaptive MPDU, while in [7]–[9], researchers proposed fairness in 802.11 by modifying contention window parameter. Another research shows that packet fairness can be achieved by minimizing hidden and exposed node problems [10], channel scheduling [11], modifying backoff mechanism in CSMA/CA [12], [13] and using time based fairness [14]–[16]. Research on small and large packet in 802.11 has also been widely studied, in [17], [18] stated that large packets will get maximum throughput but higher delay, while small packet will get smaller delay and smaller throughput.

To emphasize our problem statement, we conduct preliminary simulation using Pamvotis WLAN simulator to compare the differences between nodes with small packet size dan large packet size. Pamvotis is java based WLAN simulator that implement full functionality of 802.11a/b/g protocols [19]. In this simulation, we create two nodes with different packet size. The first node send 5000 packet/second, the size of each packet is 1500 bytes. Meanwhile the second node send 10000 packet/second and each packet contain 750 bytes. The result of the simulation can be seen in Table 1 below.

Table 1: Throughput comparison of node with large packet size and small packet size

Node	Packet size	Packet to send	Average Throughput
1	1500 bytes	7,5Mbytes/second	0,3 Mbps
2	750 bytes	7,5Mbytes/second	0,15 Mbps

Although node 1 and 2 have the same amount packet to send (7,5 Mbytes per second), but their throughput were different. Throughput for the first node is 0,3 Mbps while the second node only get 0,15Mbps of throughput.

According to [2], small size packet have less delays than bigger packet, but it cannot get an optimum throughput. Each protocol has different needs of delay and throughput. Delay insensitive protocols with small packet size could get higher throughput by aggregating its packet. In this paper, we propose fairness mechanism with selective packet aggregation based on type of protocol. By using this type of fairness, we expect to achieve optimum delay and throughput according to the needs of each application protocol.

3.0 PROPOSED SOLUTION

We proposed a simple mechanism to achieve fairness in 802.11g networks without modifying the hardware design and physical layer protocol. In order to implement our proposed mechanism, we have to handle two main problems. First, we have to choose frame aggregation mechanism that can be implemented with minimum modification, and the second is how to select protocols to be applied with frame aggregation.

Aggregating frame can be done by concatenating IP packets up to MTU size and insert the concatenate packet in 802.11 frames as payload. The frame will flow in the 802.11 network just like other standard 802.11 frame. Receiver open and check the frame payload, if it contain multiple IP packets, the receiver split those packets and send them to network layer.

Journal of Advanced Research in Computing and Applications
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Before aggregating frame, we must select which packet to aggregate and which one to leave intact. To achieve optimum delay and throughput, we can aggregate small packet which belongs to insensitive delays protocols but need more throughput. We cannot aggregate small packet that belongs to delay sensitive protocols because if we aggregate those packet, the throughput are better but it will have longer delays. The flowchart of sending mechanism can be seen in figure 1 below.

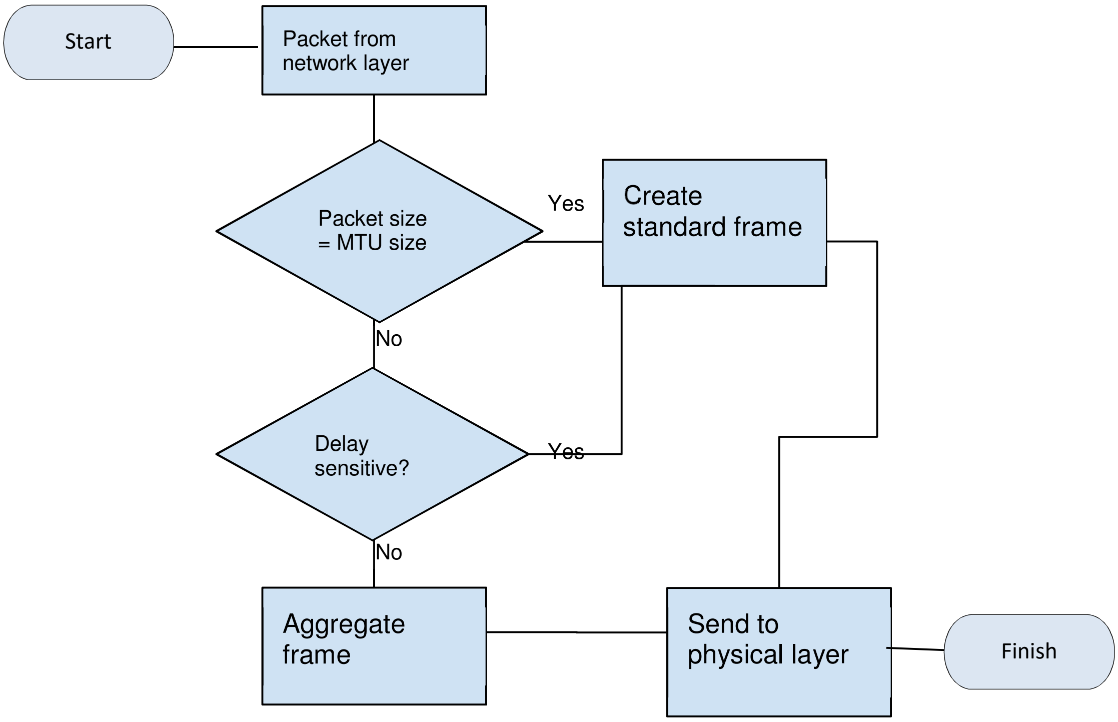

Figure 1: Proposed sending mechanism

While the receiving mechanism can be seen in figure 2 below. The receiving mechanism is much simpler than sending mechanism.

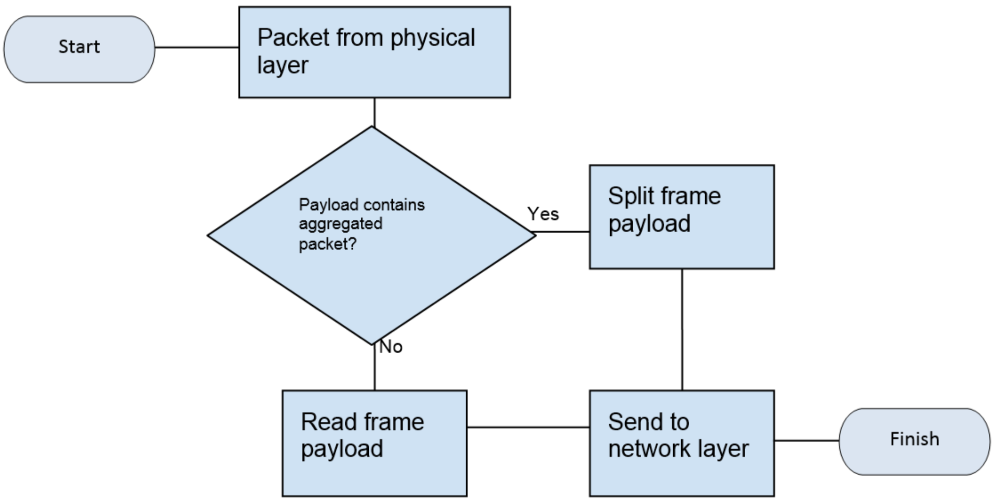

Figure 2: Proposed receiving mechanism

Our proposed fairness mechanism can coexist with standard 802.11 network, because the modified packets will be seen as standard 802.11 packets. Modification needed to implement this type of fairness are minimal. In linux, the implementation can be done in sending and

Journal of Advanced Research in Computing and Applications
ISSN (online): 2462-1927 | Vol. 2, No. 1. Pages 19-24, 2016

receiving function of the wireless card modules, so it will not affect any other networking functions.

4.0 EXPERIMENTS

We conduct some experiments by using simulation to measure the effectiveness of our proposed solution. The simulation created using Pamvotis simulator and we need to modify some of its code so that the proposed system can be tested. We modified the sending and receiving function in Pamvotis to implement the new mechanism in figure 1 and 2. The simulation design consists of 10 nodes connecting to single 802.11g network. Five nodes only transmit small packets (140 bytes) with 1000 packet per second, while the other five nodes transmit large packet (up to 1400 bytes) with 100 packets per second. The simulation runs for 100 ms simulation time and we monitor the average throughput to measure the performance of our proposed mechanism. Result of simulation using standard 802.11g implementation can be seen in table 2 below.

Table 2: Simulation result using standard 802.11g implementation

Node	Packet size	Packet to send	Average Throughput
1-5	140 bytes	140Kbytes/second	104,0771 Kbps
6-10	1400 bytes	140Kbytes/second	139,9936 Kbps

While the simulation result of our proposed mechanism can be seen in table 3 below.

Table 3: Simulation result using proposed mechanism

Node	Packet size	Packet to send	Average Throughput
1-5	140 bytes	140KBytes/second	139,9577 KBps
6-10	1400 bytes	140KBytes/second	139,8544 KBps

The simulation results show our proposed solution can give good equality of throughput on 802.11g network. Node with small packet size (node 1-5) can gain more throughput without affecting node 1-6 (nodes with bigger packet size). The result also shows that our solution can increase overall system throughput, it increased the system throughput from 122,0354 Kbps to 139,9060 KBps.

Using our proposed mechanism, throughput fairness can be achieved. By aggregating packets selectively, delay insensitive protocols with small packet size can gain maximum throughput. It will have the equal throughput just like protocols with large packet size. This mechanism also increased overall system throughput by minimizing idle time that occur while transmitting small size packets.

4.0 CONCLUSION

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In this paper, we proposed a solution to improve the performance of 802.11g by giving good equality of throughput among different size of packet. Our proposed solution can coexist in 802.11 standards for implementation and only need a little modification in data link layer. From the experiments, our proposed solution can improve overall system throughput on 802.11g networks. Although we only simulate it in 802.11g network, the same mechanism can be applied to 802.11b based network.

In this research, we still use manual identification of delay sensitive packets, so it is not feasible to implement it in real world scenario. As for future work of this research, we will create an adaptive mechanism based on protocol behaviour that can automate the identification of delay sensitive packets and conduct a real world simulation using our proposed mechanism.

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