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Supporting WiFi QoS with Priority-aware WiFi Handoff

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Abstract. Because WiFi technology becomes more popular and mobile users want continuous Internet connection through WiFi, WiFi handoff technology becomes an important issue. Also high traffic users may want high quality of WiFi connections. In this paper, we present a priority aware WiFi handoff to support WiFi QoS; the bandwidth of high priority users can be ensured by forceful handoff of low priority users. Through NS2 based simulations, we evaluate the impact of priority aware WiFi handoff to ensure QoS.

Keywords: WiFi Handoff, WiFi QoS, Priority

1 Introduction

Nowadays, the world witnesses an explosion of mobile devices. With compact design and portability, mobile devices become very popular. Along with the mobile devices, Wi-Fi technology is more and more widely used. Unlike existing wireless internet services based on cellular networks, WLAN can provide high-speed internet connectivity up to 600Mbps (four spatial streams, 40 MHz bandwidth-IEEE 802.11n [1]). In 802.11 WLANs, mobile stations connect to the Internet via APs. The range of AP is limited. When mobile users/stations moves out of communication range of AP, the connection between mobile user and AP is lost, due to limited communication range of AP. To avoid connection loss problem of mobile stations, when they move out of range of one AP; they need to associate with another AP to maintain internet connection. This switching process of mobile stations from one AP to another AP is called Wi-Fi handoff. Wi-Fi handoff is one of the main problems in Wi-Fi technology.

The Wi-Fi handoff process is executed by an event which we called as trigger. There are 6 phases in handoff process which are detection phase, scanning phase, authentication phase, association phase, 802.1X authentication phase and QoS reservation phase. The trigger is not covered in the 802.11 standards and it depends on algorithms. Normally, trigger is based on signal strength. For example, received signal strength indicator (RSSI) is less than a RSSI's threshold [4] or RSSI of target AP is more than summary of current AP's RSSI and RSSI threshold [2][3][5].

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Also quality of service (QoS) is an important criterion for Internet users. Users crave not only continuous connectivity but also high quality of connectivity. Some applications such as voice over IP or streaming application require high bandwidth. The service provider usually provides many kind of package to the users. Each package has different policies for QoS. For example, there are some packages in which user bandwidth is assured and there are some packages in which bandwidth is not assured.

According to this QoS aspect, WiFi handoff which is based on only signal strength is not good enough. For example, let us assume that there is a user with a prioritized package which ensures WiFi bandwidth, and this user uses a voice over IP application with a WiFi connection through an AP. If the user moves to the other region which is covered by other APs, WiFi handoff is triggered. In this case, if QoS is not considered, the user is going to be associated with the AP which has strongest signal, even though the AP is overloaded by many connections.

In this paper, we propose priority aware WiFi handoff method which considers the signal strength as well as the bandwidth of prioritized users. We divide users into two categories; high priority users (VIP users) and low priority users (normal users). When handoff is required, an AP needs to check the available bandwidth for VIP users. If the bandwidth is not enough for VIP users, normal users forcefully trigger handoff by the associated AP.

2 Priority aware WiFi Handoff

We consider a scenario in which users desire different level of WiFi QoS even though they pass through multiple WiFi APs. For example, a user currently using voice IP application may desire at least 300kbps bandwidth from WiFi connections during walking through a hallway where multiple WiFi APs are deployed. Also, there are some other users who have WiFi connections to access newspaper homepages. In this case, it is possible to give the user with voice IP application higher priority to use WiFi resources. The priority can be used for triggering WiFi handoff which can ensure that the prioritized users have desired level of WiFi QoS.

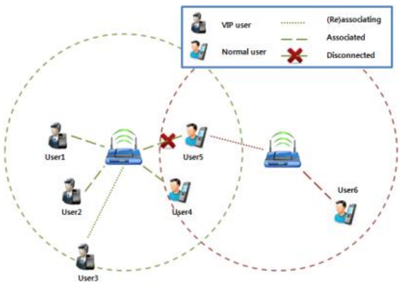

Fig. 1. A scenario of priority-aware WiFi Handoff

According to this priority consideration, we consider two types of users. There are VIP users and normal users. The bandwidth of VIP users should be assured, but the bandwidth of normal users can not be assured. That is, if an AP cannot support whole required bandwidth, AP first bans normal users in order to provide enough bandwidth for VIP users. In this point, the banned normal user starts WiFi handoff procedure to associate to another AP if possible.

The figure 1 shows an example of priority aware WiFi handoff scenario. There are 3 VIP users (user 1, 2, and 3) and 3 normal users (user 4, 5, and 6) in this scenario. At first time user 1, 2, 4, and 5 are associated with AP1, and user 6 is associated with AP2. In this time the available bandwidth of AP 1 is 200kbps. After some time VIP user 3 which wants to use 300kbps bandwidth approaches to AP1 and executes associate with AP1. At this point, AP1 cannot ensure to provide sufficient bandwidth to VIP user3, and it bans one of normal user. In this example, there are two normal users who can be banned, and user 5 is banned. But, luckily there is AP2 whose signal range covers user 5 and user 5 executes handoff process to associate with AP2.

To distinguish the priority level of users, we use AAA server such as RADIUS. AAA server is basically used for authentication of users and it is possible to embed the priority information to authentication process. That is, basically the level of priority is managed by AAA server and it distinguishes which user is a VIP user or a normal user.

3 Evaluation

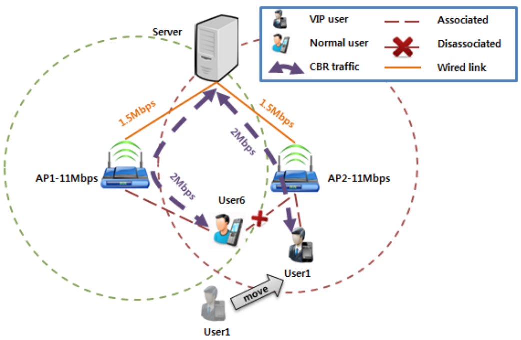

Fig. 2. Evaluation Setting

In order to understand the impact of priority aware WiFi handoff, we performed simulations using Network Simulator NS2. Figure 2 shows our simulation setting. In this scenario, there are 2 APs, 1 VIP user (User1), 1 normal user (User6) and 1 server. Each user has a Constant Bit Rate (CBR) traffic application with a UDP connection to the server. The links between APs and server are duplex-link which has 1.5Mbps bandwidth, data rate of AP is 11Mbps and CBR traffic has 1Mbps bit rate and 1000 bits packet size. We consider a scenario in which User6 is associated with AP2, and then User1 approaches to AP2. Because total required bandwidth from User1 and User6 (2Mbps) is more than total bandwidth AP2 can support (1.5Mbps), User6 is kicked out and associates with AP1 only if the priority aware WiFi handoff method is deployed on AP2. If the 802.11 standard WiFi handoff method is deployed on AP2, User 6 is not banned and both of User 1and User 6 are associated with AP2. In this case, both CBR traffics from User1 and User6 go through only AP2.

To evaluate effect of priority aware WiFi handoff method to the quality of user connection, we measure packet loss rate in both cases; priority aware WiFi handoff and 802.11 standard WiFi handoff. To measure packet loss rate, we create new agent called mUDP which extends ns2 UDP agent. In mUDP, we write to the log file whenever agent receives or sends packet. After simulation finished, we count the number of sent packets and received packets. In the case of 802.11 WiFi handoff, all packets of User1 are successfully sent to the server (packet loss rate of User1 is 0%), while almost half packets of User6 are lost (packet loss rate of User6 is 49.863%). On the other hand, in the case of priority aware WiFi handoff, User1 has the very low packet loss rate (0.004%) while User6 has a very low packet loss rate too (0.004%). Average packet loss rate of both users is 0.004% .

4 Conclusion

WiFi handoff is an important issue in these days where mobile users actively want to use WiFi resources. In this paper, we present a priority aware WiFi handoff method in order to ensure WiFi QoS for prioritized users. The priority information of users are managed by AAA server and authentication process helps to distinguish the prioritized users from the normal users. By using the priority aware WiFi handoff, it is possible to provide QoS guaranteed WiFi services across multiple WiFi APs. Also, this method can be extended to a load balancing method between multiple APs.

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