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Pre-Register Algorithm for SVC by Fast BSS Transition Wireless Networks

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***Abstract*—recently, with the more extensive deployment of Wireless Local Area Networks (WLAN), and the growing population of mobile users, the unstable handover problem in wireless network services receives more and more attention. Since users expect the continuity of services while roaming, IEEE 802 family defines the standard IEEE 802.11r (Fast BSS Transition) to reduce the interrupted time of services to the minimum. Supposing users use IEEE 802.11r to execute the pre-authentication process with all Access Points, there will be too many authenticated messages. Therefore, an IEEE 802.11r-based algorithm is proposed to avoid the pre-authentication process with all APs. In order to reduce the pre-register APs, we first of all divide the coverage of the APs into four regions according to the RSSI. Second, to figure out more accurate APs, we dynamically adjust the region. Third, if the mobile device cannot find the AP of each region, we further modify the region. Finally, we pick up an AP to execute the pre-authentication each region. With the four above-mentioned considerations proposed in this algorithm, we are able to make use of roaming more effectively.**

Keywords-component; IEEE 802.11r; SVC

I. INTRODUCTION

Wireless Local Area Networks (WLAN) is deployed in smaller areas and operates on unlicensed band. When the mobile device handoff to another AP, 6 necessary steps of the handoff process must be completed: 1) Scanning (probe exchange or listening APs' beacon), 2) IEEE 802.11 open authentication, 3) re-association, 4) Authentication method, 5) Extensible Authentication Protocol over LAN (EAPOL) key exchange, and 6) Quality of Service (QoS) re-negotiation. When the mobile device starts to handoff, the network service will be interrupted until the re-association. In order to reduce such service interruption caused by handover, IEEE 802.11r (Fast BSS Transition) is proposed. According to the specification of IEEE 802.11r, most of the authentication is completed before the association to achieve a safe and fast handover process. While associating to a new AP, the mobile device will pre-authenticate with all other access APs at the same time. Pre-authentication is able to reduce the handover interruption but too many pre-authentication messages will result in the overflow over the air. Since the main concern of this paper is to decrease pre-authenticated APs, the coverage of the mobile device is first of all separated into four regions based on RSSI variation. Second, the relationship between the moving speed and the included angle of the mobile device are taken into consideration. Third, if the mobile device cannot find the available AP to pre-register in each region, we modify the included angle of the region. Finally, an AP is chosen in each region for pre-authentication.

In addition, we apply Scalable Video Coding (SVC) to the network (802.11r) in order to offer more flexible streaming. When the mobile device is used outdoors, lots of conditions will lead to the unsteadiness of the network, such as rain fading, building fading, and roaming. Therefore, SVC offers the hierarchical Layer to adapt to the varied networks.

In this paper, we build a wireless scenario over IEEE 802.11r in which the system presents several APs (with IEEE 802.11r). The mobile device will roam in this system, and take charge of seamless handoff to prevent a lot of pre-authentication with the Access Points that will result in the extra overload of the system. The rest of this paper is organized as the following: Section 2 introduces IEEE 802.11i IEEE 802.11r systems and an application (Scalable Video Coding) that is operated under the network. Section 3 presents our system architecture and the algorithm of choosing which AP to execute the pre-authentication process. The Final section concludes this paper and discusses the future works.

II. BACKRONUND AND REELATED WORKS

In this section, we will introduce the IEEE 802.11i, IEEE 802.11r and SVC (Scalable Video Coding).

A. IEEE 802.11i

IEEE 802.11i proposes the wireless region authentication to strengthen the network security (See Fig. 1) [1] [2]. Before STA and AP transmit the data, AP should assure that the STA is a legal user, and provides the data securely. Four steps of the authenticated process are described in the following:

1) After the authentication, both STA and AS (Authentication Sever) will get the MSK (Master Session Key).

2) Both STA and AS through the same calculation, AP and AS will obtain the same MSK. Moreover, AS will deliver the PMK (Pairewise MasterKey) to AP.

3) Through the PMK, STA and AP will execute the four-way handshake to make sure that they have the same PMK.

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Afterwards, the PTK (Pairwise TransientKey) is derived from the PMK.

4) The AP generates the random GMK and after 2-way handshake generating GTK.

5) Data should be encrypted by using the PTK when data is transmitted over the air, and using the GTK to protect the broadcast or multicast.

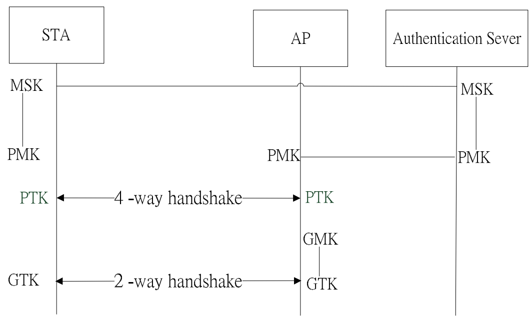

Figure 1. IEEE 802.11i authenticated process

B. IEEE 802.11r

Based on IEEE 802.11i, IEEE 802.11r [3] [4] [5] [6] [7] specifies a new key management (see Fig. 4) with the attempt to offer seamless and secure handoff. IEEE 802.11r Key management includes three levels. First, level 0 key holder (R0KH) stores the PMK-R0 derived from MSK (Master SessionKey) and PSK (Pre-Shared Key), and prepares to calculate the PMK-R1 (Pairewise MasterKey). IEEE 802.11r specifies the generation of the PMK when an AP joins the network. All APs that are authenticated in the same subnet should get the PMK. Next, level 1 key holder (R1KH) stores the PMK-R1 derived from the PMK-R0 from the previous level and prepares to calculate PTK and the BSSID. Finally, the last level key holder stores the BSSID calculated from the PMK-R1. All APs are assumed to be in the same security domain. When the mobile device first connects to the AP, the original handoff steps are used to access the network. Simultaneously, by using IEEE 802.11r (Fast BSS Transition), the mobile device pre-authenticates with the BS that it can access (see Fig. 2). The mobile device connects with AP A and obtains BSSID A 1st; and at the same time, the mobile device executes pre-authentication that obtains BSSID B 1st and BSSID C 1st. When the mobile device executes handoff process again, the handover time can be substantially reduced. In the mean time, the mobile device re-authenticates with the AP that it can access to ensure the network security (see Fig. 3). By using BSSID 1st, the mobile device connects with AP B and at the same time, re-authenticates with AP C and obtains the new ID, BSS ID C 2nd for the network security.

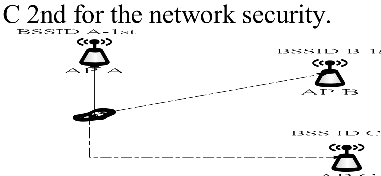

Figure 2. The mobile device first accesses to the network

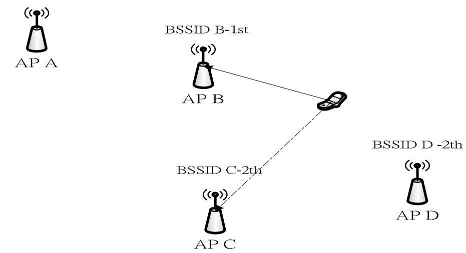

Figure 3. The mobile device is hand-offing to AP B and will re-authenticate with AP-C and AP-D

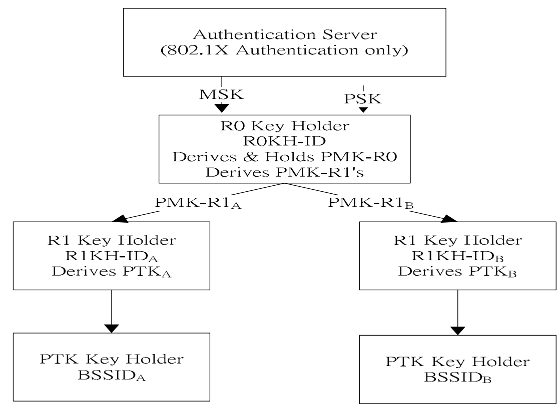

Figure 4. IEEE 802.11r Key Hierarchy

C. SVC (Scalable Video Coding)

With the emergences of new applications like VOIP and video streaming, the uninterrupted video services become more noteworthy. Nevertheless, in the wireless network, the signal may encounter some conditions, such as signal fading, unstable bandwidth, bit error or packet loss. When a user is using the streaming service, the streaming sever should consider the user’s capacity of wireless receive. SVC (Scalable Video Coding) [8] [9] allows users to decode videos in different qualities that agree with the network bandwidth or users’ requests.

SVC offers hierarchical Layers, which include a Basic Layer and several Enhancement Layers (See Fig. 5). In Figure 4, SVC classifies the video data into the Basic Layer and the Enhancement Layers (Layer 1 and Layer 2). After detecting the network condition and the user’s request, SVC makes the decision to transmit different Layers. At the beginning, because the network condition is not good, SVC transmits the Basic Layer only. After 10s (at 20sec), SVC detects that the network can transmit more data, and next transmits the streaming of the Basic Layer and the Enhancement Layers (includes Layer 1 and Layer 2). At 30s, the network bandwidth becomes unstable, and SVC transmits the video data of the Basic Layer and Layer 1. Generally speaking, the Basic Layer offers a static coding method but the Enhancement Layers can alter the coding method to match the network demands. According to the Scalability, Temporal and SNR, the Enhancement Layers can choose different coding methods to transmit the video data.

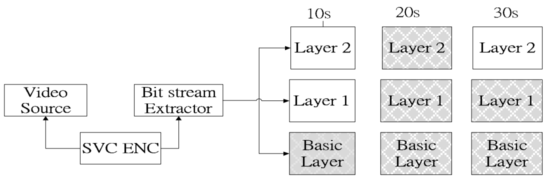

Figure 5. SVC's hierarchical Layer

III. SYSTEM ARCHITECTURE

This paper assumes that there is one mobile device within the range of several Access Points (see Fig. 6). The mobile device moves toward irregular directions. [10] [11] [12]

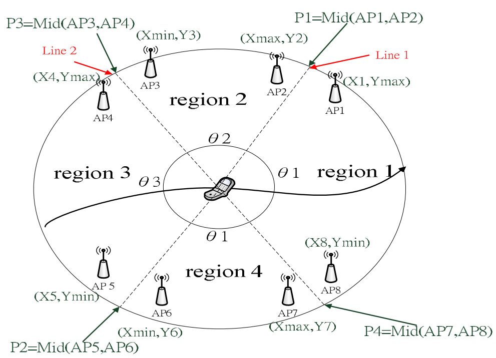

Figure 6. The region of the mobile device

According to the received RSSI, the coverage of the mobile device is divided into four directions (See Fig. 6).

Case 1: ΔRSSI >0, is set to be region 1, which indicates that the mobile device is approaching the AP.

Case 2: ΔRSSI =0, indicates that the mobile device is located at the right (or left) side of the AP. The right or left side is defined based on the marching direction of the mobile.

$$\Delta RSSI = 0, \begin{cases} \text{region 2 :left side} \\ \text{region 4 :right side} \end{cases}$$

Case 3: ΔRSSI <0, is set to be region 3, which indicates that the mobile device is moving away from the AP.

After defining four regions' meanings, we discuss the "side line" for the regions. Based on the moving direction and the edge of the region, we can find the AP which approaches the side line.

For example, in Fig 6, the mobile device moves toward the X axis, therefore we can find AP1(Y-axis_max) and AP8(Y-axis_max) as the edge of AP

After finding the AP which approaches the side line, we define the region of the line. The equation is shown in the following.

Line1:
P1=Mid (AP1, AP2), P2=Mid (AP5, AP6)
AP1= (X1, Ymax), AP2= (Xmax, Y2),
AP5=(X5, Ymin), (AP6=Xmin, Y6)
=>Line1's slop= $m_1=\frac{P2y-P1y}{P2x-P1y}$
=>Line1's equation: $Line1_y - P1y = m_1(Line1_x - P1x)$ (1)

In the formula, P1 is the middle point between AP1 and AP2; P2 is the middle point between AP5 and AP6. According to the slop and the through point P1 (or P2), we can define the Line1's equation. AP1, AP2, AP5 and AP6 are the edge of APs. And the Line2's equation is similar as Line1's.

Line2:
P3=Mid (AP3, AP4), P4=Mid (AP7, AP8);
AP3= (Xmin, Y3), AP4= (X4, Ymax)
AP7= (Xmax, Y7), AP8= (X8, Ymin)
=>Line2's slop= $m_2=\frac{P4y-P3y}{P4x-P3y}$
=>Line2's equation: $Line2_y - P3y = m_2(Line2_x - P3x)$ (2)

In the formula (2), P3 is the middle point between AP3 and AP4; P4 is the middle point between AP7 and AP8. According to the slop and the through point P3 (or P4), we can define the Line2's equation. AP3, AP4, AP7 and AP8 are the edge of APs.

Second, the relationship between four directions and the mobile device's moving speed are taken into account. The faster the mobile device moves, the less probable it is to change the direction suddenly. The faster the mobile device moves, the smaller the θ is. Thus, we are more inclined to find out the accurate AP to connect to (See Fig. 6). We assume that the θ is an inverse ratio to the speed, $\theta \propto \frac{1}{v}$

$$\theta 1' = \beta * V + 90^\circ, 90^\circ < \theta 1 < 180^\circ \quad (3)$$

$$\theta 1' + \theta 2 = 180^\circ, \theta 1' = \theta 3, \theta 2 = \theta 4$$

In the formula, θ is the region's included angle and v represents the moving speed of the mobile device (km/hr). β is the dynamical parameter. In this paper, we assume that the highest moving speed of the mobile device is 300 km/hr. The range of the θ1 is between 0° and 90°. Therefore, $\beta = \frac{90}{300} = 0.3$

Assuming that $\Delta\theta 1 = (\theta 1' - \theta 1) = \delta$, we compute the renew side line (See Fig. 7). And modify δ/2 angle each side line

$$(X', Y') = [\cos\frac{\delta}{2}, \sin\frac{\delta}{2}] \quad (4)$$

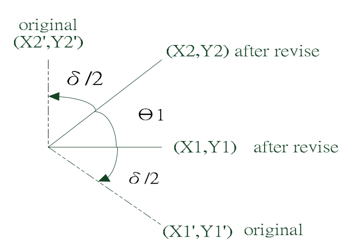

Figure 7. modify the Line1 and Line2

Third, if the mobile device cannot find the AP for pre-authentication in the region, we adjust the included angle of the region until the AP is found.

$$\theta i = \theta i + \gamma^\circ, \theta 1 + \theta 2 = 180^\circ, \theta 1 = \theta 3, \theta 2 = \theta 4 \quad (5)$$

In this paper, we assume that the γ is 10°, it expands angle of the region 10° each time.

Finally, in order to find an AP for pre-authentication, the throughput users can obtain is taken in to consideration and the throughput provided by the AP is assumed to be fixed.

$$T_{md} = \frac{1}{Ui+1} T_H \qquad (6)$$

In the above formula, Tmd refers to the throughput the mobile device can obtain after participating into the new AP. Ui stands for the number of users that are originally served by the new AP. T_H denotes the throughput the new AP can provide.

IV. SIMULATION RESULTS

In this simulation, NS2 is adopted to set the wireless scenario, which includes several mobile devices and nine APs, as shown in the following Fig. 8. The data flow of the Mobile devices is set to be 11M and we assume that the mobile device 1 moves from AP1 to AP3. This paper investigates the receiving data transition delay with the original handover and the Fast BSS handover (See Fig.9 and Fig.10). During the Fast BSS handover procedure, the transition delay gradually slows down because of the pre-authentication process.

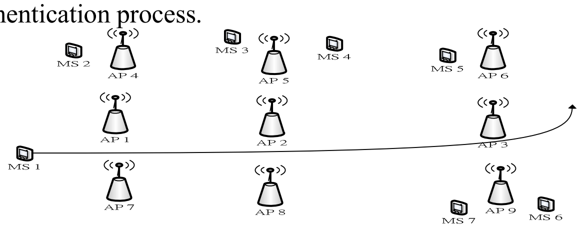

Figure 8. The transition overview of the mobile device

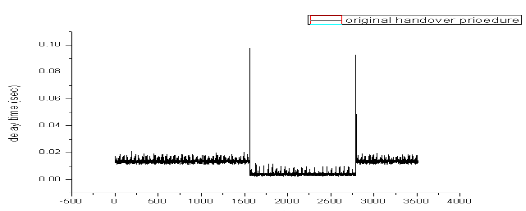

Figure 9. The delay time of the original handover procedure

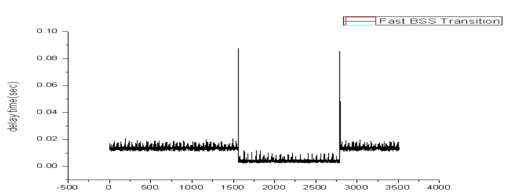

Figure 10. The delay time of the original handover procedure

Finally, we calculate the pre-authenticated messages in the original handover and the Fast BSS handover, and further use our algorithm to choose four pre-authenticated Access Points (See Fig.11).

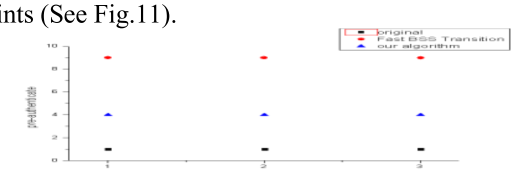

Figure 11. Amount of the pre-authenticate message

The original handover results in the longer handover delay. Fast BSS Transition decreases the delay, but there will be too many pre-authenticated messages over the air. With our proposed algorithm, the pre-authenticated messages can be reduced substantially.

V. CONCLUSIONS

In recent years, the mobile communication equipments become the main stream and the real-time services receive more and more attention. Thus, IEEE802.11 (Fast BSS Transition) specifies the fast handoff procedure: by completing most of the handoff procedure before the association, the delay caused by the handover can be greatly reduced. This paper proposes a method to choose four pre-authenticated APs. This method decreases not only the handover time but also the pre-authenticated messages. Moreover, this paper also proposes finding out the best BS by computing the throughput that the device can obtain.

In order to enrich the service devices, our future plan is to include the cellular networks. With the mobile communication equipments, users can have more options and more convenience. The interference is also an important subject. These two directions could be the future targets of our workshop.

VI. ACKNOWLEDGMENT

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