3G Research on MAC Communication Mechanism of Air-to-Ground Data Link Based on 3G The MSDU Frame Subsection and RTS CTS Handshake Mechanism
Research on MAC Communication Mechanism of Air-to-ground Data Link Based on 3G

The MSDU Frame Subsection and RTS/CTS Handshake Mechanism

Minghui LI, Jingbo XIA
Telecommunication Engineering Institute
Air Fore Engineering University
Xi’an, China
e-mail: airminghuili@163.com

Yaoguo WANG
Unit 94326
The People’s Liberation of Army
Jinan, China

Abstract—In order to settle the conceal terminal, frequency shift, losing package, mistaking code problems of air-to-ground data link, which were aroused by high speed moving of node and more complicated network environment, two important MAC communication mechanism—the MSDU frames subsection and RTS/CTS handshake mechanism—were introduced. Then some simulation experiment were made from little operation and much operation aspects, and some simulation analyse was given. Finally, some useful conclusion is got.

Keywords—MAC; data link; MSDU; frames subsection mechanism; RTS/CTS; handshake mechanism

I. INTRODUCTION

Related to line communication, some problems take place in the radio communication because of the complexity of channel and instability of topology, for example, reliability and stability are bad, data frame collides easily, and could not forecast collision accurately through introducing CSMA/CD protocol. Then because of the high speed moving of node, more complicated network environment, the air-to-ground data link has much more problems than radio communication. There are much more prominent conceal terminal problem, frequency shift problem, losing package, mistaking code and so on[1-5].

Researching on the transmission of down link video operation of air-to-ground data link is the key and important part of air-to-ground data link system based on 3G. So how to introduce video operation to air-to-ground data link based on 3G, and how to assure the effective transmission of data in the complicated network environment in which above problems exist. Aiming to these circumstances, we study the MAC communication mechanism and parameter configuration, in order to improve communication quality and access mode.

Now, two important MAC communication mechanism were introduced, the MSDU frames subsection and RTS/CTS handshake mechanism, then some simulation analyse were given from little operation and much operation aspects, finally, some useful conclusion is got.

II. THE MSDU FRAME SUBSECTION MECHANISM

Introducing the frames subsection mechanism in air-to-ground communication, it could improve frame error rate, especially the video flow data packets are much longer. Because in this case, radion transmission environment is more complicated, continuous data segment is prone to error.

Now an analyse of the MSDU frame subsection mechanism[6,7,8] is given.

Supposed the number of packet bits is L, bit error rate is Pe, error correction rate of correction coding is Ecc. If the number of bit error is larger than 8L*Ecc, it makes know that the packet is error, and may losing packet or sending again, then frame error rate is

$$P = 1 - \sum_{i=0}^{8L*Ecc} \begin{pmatrix} 8L*Ecc \\ i \end{pmatrix} P_e^i (1-P_e)^{(8L-i)}$$

(1)

Because one packet is as a transmission frame, the efficiency of frame transmission is

$$\eta = \sum_{i=0}^{8L*Ecc} C_{8L*Ecc}^i P_e^i (1-P_e)^{(8L-i)}$$

(2)

If fragmentation threshold is given, and make the packet into some short MSDU frames, it will minish the above effect greatly. Supposed the fragmentation threshold is T, then the packet that the length is L is divide into n=[L/T] MSDU frames, and frame error rate is

$$P_f = 1 - \sum_{i=0}^{8T*Ecc} C_{8T*Ecc}^i P_e^i (1-P_e)^{(8T-i)}$$

(3)

Then the efficiency of frame transmission is

$$\eta_f(T, P_e) = \frac{8L - 8n TP_e^T}{8L} = 1 - k[1 - \sum_{i=0}^{8T*Ecc} C_{8T*Ecc}^i P_e^i (1-P_e)^{8T-i}]$$

(4)

In formula (4), $k = \frac{nT}{L}$. When the length of packet L is quite great, k will be close to 1, Ecc is system fixed value. So according to different fragmentation threshold T, the effect of T to $\eta_f$ could get[10-12], which is shown in Figure 1.

The theory analysis indicates that whether the system is in low bit error rate (BER) or high bit error rate (BER), short frame will improve the transmission efficiency of system.
III. The RTS/CTS Handshake Mechanism

Request-To-Send/Clear-To-Send protocol (RTS/CTS) is a MAC protocol in IEEE 802.11 standard of Wireless Local Area Network (WLAN), which is defined in order to settle conceal terminal problem. It is also the main method of eliminating the problem in fact. So it is important and useful to introduce the RTS/CTS handshake mechanism into air-to-ground data link based on 3G.

In IEEE 802.11, there are three access modes: competitive CSMA/CA (basic access mechanism), RTS/CTS handshake mechanism, and point coordinator function (PCF) mechanism[13-15].

- PCF provides service to uncompetitive time-restricting transmission mode and asynchronism transmission mode (ATM), and calls for complex MAC request. So there are no much product sustaining this service in WLAN.
- The basic access mode asks the destination respond a frame to the source when it has received the data from the source.
- RTS/CTS offers a short handshake before data sending, and acquires access of channel. And the destination also responds a frame to the source when it has received the data from the source.

The elementary access mode and RTS/CTS Handshake Mechanism are shown in Figure 2 and 3.

The length of IEEE 802.11 interval frames (IFS) is used to intercalate PRI of send frame, it includes short interval frames (SIFS), PCF interval frames (PIFS), DCF interval frames (DIFS) and extended interval frames (EIFS). The PRI of SIFS is the highest, such as the data frame in RTS/CTS. The PRI of DIFS is lower, and the data frame in elementary access mode is this kind. IEEE 802.11 intercalates network assigning vector (NAV) signal for suppositional carrier sense mechanism, the purpose is to prevent channel competition between present data and other data in stated time.

In the process of RTS/CTS handshake, the source sends RTS frames to all the terminals in area overlay, all the non-destinations that receive the frames stop exchanging data. At the same time, the destination sends CTS frames to the source and tell the source that it has got ready, then the source and the destination could transfer data.

There is time information that channel occupancy in RTS/CTS, other nodes can rectify their NAVs according it. At the same time, RTS/CTS uncompetitive transmission service is choice in node parameter, but all WLAN nodes must sustain this service in order to respond to it.

Therefore, RTS/CTS sets up dedicated channel for some data transmission of some nodes actually, in this way, it not only eliminated conceal terminal problem effectively, but also provided credible transmission for important data[16-18].

So it is essential to introduce the RTS/CTS handshake mechanism into air-to-ground data communication based on 3G.

Although RTS frame and CTS frame are all relative short (RTS frame is 20 bytes, and CTS frame is 14 bytes), the additional spoilage would take place. The more the DATA region, the higher the transmission efficiency is. So RTS/CTS mechanism realizes according to RTS treshold. When the length of MSDU frame is lower than the RTS treshold, the RTS mechanism is not adopted, otherwise, the RTS mechanism is adopted. We can use this way to assure the transmission of longer data frame effectly. However, some problems are also occurred in longer data frame, because lossing packet rate and bit error rate are higher in radio transmission. When the lossing packet rate and bit error rate are the same, longer frame has much more spoilage than low frame. So IEEE 802.11 regulates the MAC frame fragmentation mechanism, sets fragmentation threshold. When the length of MSDU frame is higher than the fragmentation threshold, the old frame would be divided and packed into two or more MSDU frames, otherwise the old frame is not changed. According to above, it is obvious that RTS threshold should be under the fragmentation threshold.
IV. THE SIMULATION ANALYSE

In order to analyse the two Mechanism, the MSDU frame subsection mechanism and RTS/CTS handshake mechanism through simulation experiments, now some simulation analysis were given from little operation and much operation aspects.

A. The Little Operation Simulation Analyse

In this scene, the all network operation is little, some simulation experiments were made. We chose representative RTS threshold and fragmentation threshold, such as $R_{th}=512$, 256 and NONE, $F_{th}=768$, 512, 256 and NONE, then contrasted the results. Now $(R_{th}, F_{th})$ expressed the RTS threshold and fragmentation threshold of every curve, the effect of two mechanism to average throughput and average access delay is shown in Figure 4 and 5 respectively.

![Figure 4. The effect of two mechanism to average throughput in little operation](image)

![Figure 5. The effect of two mechanism to average access delay in little operation](image)

From the figure 4, we could know that the node average throughput is much stabler when it introduced the two mechanism than only one mechanism is used in air-to-ground communication, and the average throughput was not under 11,000bits/s. When $R_{th}=512$, $F_{th}=768$, the system capability was prominent; and the capability were adjacency when $R_{th}=256$, $F_{th}=512$ and $R_{th}=512$, $F_{th}=512$.

The figure 5 showed us the improvement of average access delay, the delay of three parameter groups, as $R_{th}=512$, $F_{th}=512$, $R_{th}=512$, $F_{th}=768$, $R_{th}=256$, $F_{th}=512$, were all 0.0075s when they were in stable states, falling near 0.01s to $R_{th}=NONE$, $F_{th}=NONE$. When $R_{th}=512$, $F_{th}=512$, it was not in stable state between 5min and 20min, so when $R_{th}=256$, $F_{th}=512$, the system capability was prominent.

B. The Much Operation Simulation Analyse

In much operation simulation, there were some differences then little operation. We also made some experiments, then contrasted all the simulation results, chose one data of common transmission $(R_{th}=NONE$, $F_{th}=NONE)$, only MSDU frames subsection $(R_{th}=NONE)$, only RTS/CTS handshake $(F_{th}=NONE)$ and two mechanism. We also used $(R_{th}, F_{th})$ expressing the RTS threshold and fragmentation threshold of every curve, the effect of two mechanism to average throughput and average access delay is shown in Figure 6 and 7 respectively.

![Figure 6. The effect of two mechanism to average throughput in much operation](image)

![Figure 7. The effect of two mechanism to average access delay in much operation](image)
From the figure 6, we can get that the effect of two mechanism to average throughput in much operation was not obvious, and there no more difference among above four cases, at most 500bit/s.

In Figure 7, when only Fth=512 was introduced, the node capability was a little more excellent than common, and the delay depressed near 0.005s. When using the only Rth=256 RTS threshold mechanism and two mechanism (Rth=256, Fth=512), the delay was nearly all the same, as 0.015s, and the latter much better, the delay of it depressed near 0.03s, the state was also balanced.

From above two simulation analyse, we can see that the two mechanism were important in air-to-ground data communication based on 3G. Now, we must attach importance to the two mechanism and the integratation of two mechanism with 3G communication mechanism.

V. CONCLUSION

In sum, the two mechanism are introduced into air-to-ground data link based on 3G through improving the parameter capability and configuring the two threshold, the communication quality and efficiency of air-to-ground data link would improve greatly. In it, we improve the transmission validity by MSDU frame subsection mechanism, and improve the reliability by RTS/CTS handshake mechanism.

According to simulation, we can get the conclusion that when the MSDU frame subsection mechanism and RTS/CTS handshake mechanism are introduced into the air-to-ground data link based on 3G, the conceal terminal problem is settled effectly and the network capability is improved greatly.

ACKNOWLEDGMENT

The authors would like to thank the anonymous reviewers for their valuable and constructive comments that helped improve the presentation of this paper substantially.

REFERENCES


